CARE COORDINATION, QUALITY AND OUTCOMES: A STUDY IN OLDER ADULTS WITH MULTIPLE CHRONIC CONDITIONS

By
Eva Hisako DuGoff

A dissertation submitted to The Johns Hopkins University in conformity with the requirements for the degree of Doctor of Philosophy.

Baltimore, Maryland
August 2014

Abstract

Background: Care coordination may be most effective in older adults with multiple chronic conditions because they see multiple primary care and specialist physicians, which may complicate efforts to coordinate care for their conditions. There is little evidence on how to best measure and improve care coordination in this population.

Objective: The objective of this thesis is to better understand care coordination in older adults with multiple chronic conditions. The first study examines how to measure care coordination. The second study examines the relationship of care coordination with quality of care processes and patient rating of care. The third study whether one dimension, continuity of care, is associated with subsequent emergency department utilization, and hospital utilization.

Study Design: This is an observational study. All analyses were conducted in a sample of 1,600 adults 65 years of age and older with multiple chronic conditions selected to participate in a patient survey. All subjects were enrolled in a Medicare Advantage Special Needs Plan living in Alabama, Georgia, Missouri, South Carolina, and Texas.

Results: The first study identifies three underlying domains of care coordination: continuity of care, informational continuity between clinicians, and information flow to the patient. The second study finds that patient reported experiences of informational continuity are strongly related to the patient related to the patient's rating of care, but not related to other measures of technical care quality. The third study finds that higher levels continuity of care is associated with lower odds of a preventable hospitalization in patients with five or fewer conditions but continuity of care is not related to better outcomes in patients with six or more conditions.

Conclusion: Care coordination is a multidimensional construct. Evaluations of care coordination programs should consider using both claims-based and patient survey measures in order to comprehensively assess care coordination programs. Medicare and health plans should consider incentivize informational continuity between clinicians to improve patient rating of care.

Thesis Readers:
Gerard F. Anderson, PhD (Advisor)
Bruce Leff, MD, MHS (Chair)
Judith Kasper, PhD
Karen Bandeen-Roche, PhD

Alternate Readers:
Jodi Segal, MD
Emma Elizabeth McGinty, PhD, MS

Acknowledgements

This project would not have been possible without Gerard F. Anderson, my thesis advisor and mentor. He has been a constant source of encouragement, advice, and constructive criticism. I and my project have also benefited from a wonderful group of mentors who also served as my dissertation committee: Karen Bandeen-Roche, Judy Kasper, and Bruce Leff.

The origins of this thesis are in questions Senator Ron Wyden once asked me. I owe a great deal to Senator Wyden and his team (Jeff, Joshua, Emily, Liz, Jennifer, Laura, Ben, Michelle, Jackie, Kathleen, and Tom). I learned so much in my time with you. Thank you for letting me help you fight the good fight and stand tall for the people of Oregon.

I owe so much to my family. Thank you for your support throughout this project and all the ones to come. I especially want to thank my Helen who has been my anchor, cheerleader, best friend, partner, and light at the end of the tunnel. I'm very so very blessed to have her in my life.

I am very grateful to my friends. From biostatistics to job talks, Beth, Christine, Lisa, Dana, Evan, Eric, and Dave, have always been there. You are my colleagues and friends. Thank you for always being ready to talk shop or share a laugh and a pint or do both at the same time. A big thank you to my friends on the outside: Jenna, Jayne, Maura, Joachim, Frank, Sara, Dave, Sarah, Virginia, Rachel, Ralphie, Yancy, and Cat.

This dissertation project benefited from the financial support of the Agency for Healthcare Research Quality National Research Service Award, the Tarlov & Ware Pre-Doctoral Dissertation Award in Patient Reported Outcomes, Care Improvement Plus, and

the Blue Cross Blue Shield Hal Cohen Scholarship. In addition, the conceptualization of this project benefited from the feedback and on-the-ground experience of the talented and dedicated team at Care Improvement Plus: Robb Cohen, Laurie Russell, and Jeff Schoenborn.

For my grandparents:
Tadashi, Yoshiko, Al, Edie, Bob, and Judie

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Chapter 1: Introduction

1.1. Introduction

Older adults with multiple chronic conditions account for over 95 percent of medical care utilization and health care spending in the Medicare program (Anderson 2010; Centers for Medicare and Medicaid Services 2012). Chronic conditions are illnesses requiring ongoing medical care. Most older adults are managing more than one chronic condition (Anderson 2010; Centers for Medicare and Medicaid Services 2012). Typically, a patient and his or her spouse are the ones trying to coordinate multiple medication schedules and medical advice between multiple physicians across different practices (Boyd et al. 2005; Pham et al. 2007; Pham et al. 2012; Wolff and Kasper 2006). Even though patients with multiple chronic conditions need the most help, there is rarely a provider that is tracking their care let alone coordinating their care in real time.

In an effort to improve care for older adults, Medicare along with private health insurers, and health care providers have launched a variety of new care coordination interventions: provider accountability and infrastructure investment in Accountable Care Organizations, comprehensive primary care services through Patient Centered Medical Homes, hospital to home transition support through Care Transitions, and home-based primary care services under the Independence at Home program (McWilliams, Landon, and Chernew 2013; Thorpe and Ogden 2010; U.S. Department of Health and Human Services 2010). These new models are not Medicare's first foray to improve care coordination. In the previous decade, Medicare created Medicare Advantage plans for people with severe and disabling chronic illnesses and tested the Medicare Coordinated

Care Demonstration; prior to that Medicare experimented with the Program of All-Inclusive Care for the Elderly (PACE), case management, and managed care (Brown et al. 2008; Hirth, Baskins, and Dever-Bumba 2009; McGuire, Newhouse, and Sinaiko 2011; Schore, Brown, and Cheh 1999).

These and other care coordination interventions often have disappointing results (Boult and Wieland 2010; Nelson 2012; Peikes et al. 2009). There are several plausible explanations why many of the care coordination interventions have not yet been successful. The *right formula*: these programs are not providing the combination of services or incentives necessary to meaningfully change care utilization and health. *Targeting*: Brown and colleagues suggest that these programs are not targeting the patients who can most benefit from additional services—their patient population is too healthy (Brown et al. 2012). *Poor implementation*: The interventions have identified the necessary set of services and target the appropriate people, but they are not implementing these programs well. *Inadequate measurement*: care coordination interventions may have beneficial efforts, but our measures may not adequately capture these improvements because the measures are invalid or they measurement period is insufficient to see change. Lastly, care coordination programs may not benefit people with many chronic conditions. Since these patients are likely to be the most expensive people, they will affect the results.

The failure of care coordination programs to show clear benefits raises critical questions about how well we understand the nature of care coordination in older adults, especially those with multiple chronic conditions who may the most to benefit from additional services; and how well to measure the success of these programs and their

providers. Careful study of how to measure the success or failure of care coordination in older adults with multiple chronic conditions is important for both designing effective interventions and assessing program performance. We explore these issues of measurement in Chapters 2 and 3. Since these patients are likely to be the most expensive people and have the worst outcomes, controlling their health care expenditures and utilization is necessary for success. Unfortunately, few studies have focused on older adults with multiple chronic conditions (Worrall and Knight 2006). In Chapter 4, we examine whether the relationship between the relationship between continuity of care and health outcomes varies by level of morbidity.

I examine these issues in the context of older adults with diabetes and other chronic conditions enrolled in a Medicare Advantage Special Needs Plan. Diabetes is a common chronic condition affecting about 28% of the elderly in the Medicare program (Centers for Medicare and Medicaid Services 2012). It is a leading cause of death in the United States (Minino 2011). Plan members may receive a range of care coordination services often used in care coordination programs including case management, disease education, and post-hospitalization follow up care.

1.2. Literature Review

This section reviews the relevant literature related to each study aim. This review is not intended to be a comprehensive or systematic review. The goal is to describe the existing evidence base and to identify gaps in the literature.

1.2.1. Measuring Care Coordination

Care coordination interventions are often multifactorial targeting medical practice, community resources, and patient self-management (Boult, Karm, and Groves 2008; Boult and Murphy 2011; Brown et al. 2012; Wagner, Austin, and von Korff 1996). Yet, care coordination program success often hinges on specific outcomes—such as whether the program reduces hospitalizations and readmissions (Brown et al. 2008; Dugoff et al. 2013). While these outcomes may be affected by poor care coordination, recent studies suggests that a relatively small proportion of hospitalizations and readmissions are actually preventable (Gorodeski, Starling, and Blackstone 2010; Joynt and Jha 2012; van Walraven et al. 2011), suggesting that the ability for care coordination interventions to show marked improvement in these outcomes may be limited.

One possible explanation why past care coordination interventions have had disappointing results is that we are not measuring what these programs are doing well. One challenge in evaluating care coordination interventions is that there is not a consensus definition in the literature. For example, care coordination can be defined very broadly: “any activity that helps ensure that the patient's needs and preferences for health services and information sharing across people, functions, and sites are met over time (McDonald et al. 2010).” Care coordination can also be considered as covering a very narrow set of activities: “as the extent to which care providers recognize information on

patients from one visit to the next and are aware of the involvement of other care providers (Uijen et al. 2012)." For this study, we consider care coordination broadly because older adults with multiple chronic conditions may have multiple medical care providers as well as other caregivers involved in their care (Pham et al. 2007). Care coordination is "the deliberate organization of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of health care services (McDonald et al. 2007)."

Care coordination can be measured using multiple sources of information such as administrative claims data and patient survey data. We identified 21 potential claims-based measures based upon published systematic reviews of the literature (Jee 2006; Van Walraven et al. 2010). Claims-based measures quantify care coordination based upon visit patterns in a specific time period. For example, the two most common measures of care coordination, the Continuity of Care Index (COC) and Usual Provider of Care Index (UPC) quantify the dispersion of care across providers and the concentration of care within a specific provider, respectively (Bice and Boxerman 1977; Breslau and Reeb 1975).

A systematic review identified over 60 different surveys designed to measure care coordination (McDonald et al. 2010). Common survey instruments used to measure aspects of continuity are the Primary Care Assessment Survey (PCAS), Primary Care Assessment Tool (PCAT) and Patient Assessment of Care for Chronic Conditions (PACIC). While each of these surveys have been used previously, these surveys have are not always appropriate for studying patients with multiple chronic conditions. For example, the PCAS and PCAT focus on care received from the primary care physician,

and do not capture other elements of the patient's health care experience in hospitals, emergency rooms, or specialists (Safran et al. 1998; Shi, Starfield, and Xu 2001). The PACIC is a 20-item survey developed to assess the Wagner Chronic Care Model (Glasgow et al. 2005). The PACIC has become a widely used instrument for its brevity and ability to detect changes in the patient's experience of care in studies looking at self-management support and patient-centered medical home models (Boyd et al. 2010; Reid et al. 2009). However, the PACIC not only does not inquire about care received in hospitals or emergency rooms, but it has been criticized because subsequent evaluations have found the survey exhibits poor construct validity (Spicer, Budge, and Carryer 2010).

We collect patient reported experiences with care coordination using the Hopkins Chronic Care Survey, which was designed to examine care coordination in patients with multiple chronic conditions. The survey was designed as part of the dissertation. The mail survey includes 45 questions about care coordination, diabetes care, hospitalizations, emergency room visits, patient rating of care, and demographics. The survey is available in the appendix. The survey underwent cognitively testing in a convenience sample of four older adults (age>60 years). The advantage of the Hopkins Chronic Care Survey over other surveys in the literature is that it takes a broader view of care coordination. This survey asks about coordination between care settings (hospitals and emergency departments), diabetes specific items, as well as questions on both the usual provider and specialists. In addition, the survey collects potentially valuable information on patient-level enabling and need factors not collected in other surveys, such as: depression, caregiver accompaniment during medical visits, diabetes related distress, and distance to the primary provider.

Previous studies comparing claims-based and patient-reported care coordination have found that these measures are not highly correlated (Bentler et al. 2013; Liss et al. 2011; Rodriguez et al. 2008; Wasson et al. 1984). Based on this evidence, some researchers suggest focusing solely on administratively-derived measures because they are less subject to response and recall bias (Rodriguez et al. 2008). Other researchers suggest that administrative and patient measures captures different aspects of care coordination (Wasson 2009). We examine whether care coordination is multidimensional in Chapter 2 using factor analysis.

1.2.2. Care Coordination and Quality of Care

Care coordination interventions are expected to improve both clinical quality and patient rating of care. Clinical quality is typically measured with respect to clinical practice guidelines (Brook, McGlynn, and Cleary 1996). Patient rating of care is measured using patient surveys.

It is important to note that assessing quality of care in people with multiple chronic conditions is challenging because few clinical practice guidelines define appropriate care for people with multiple co-morbidities (Boyd et al. 2005; Tinetti, Bogardus, and Agostini 2004). In some cases, disease specific guidelines may conflict or suggest services that may provide little marginal benefit to complex patients (Tinetti et al. 2004). In addition, older adults with multiple chronic conditions often see multiple physicians (Pham et al. 2007), increasing the likelihood that some patients receive care concordant with clinical standards because they have more contact with the health care system. Previous studies assessing quality of care in older adults with multiple chronic conditions report that the likelihood of receiving good care increases with clinical

complexity as measured by number of co-morbidities (Bae and Rosenthal 2008; Higashi et al. 2007; Min et al. 2007; Woodard et al. 2011). However, these studies continue to find that a substantial proportion of older adults do not receive care consistent with clinical practice guidelines.

Recent care coordination programs and other observational studies have only found limited evidence of a relationship. For example, an observational study in adults with diabetes found no evidence that continuity of care was associated with common diabetes quality measures: receipt of a glycosylated hemoglobin test, lipid test, and a retinal eye exam during the year (Gill et al. 2003). Similarly, a recent evaluation of the patient centered medical home model in Pennsylvania primary care practices found that intervention practices had better adherence to only one of 11 quality measures (Friedberg et al. 2014). A 15-site randomized controlled trial of care coordination interventions in the Medicare program had similarly disappointing results (Peikes et al. 2009). Other studies focusing on relational and longitudinal continuity, as measured by the report of a usual source of care and length of one's relationship with a provider, have reported a positive relationship between receipt of preventive services and patient satisfaction (Cabana and Jee 2004; Weiss and Blustein 1996).

Previous studies of care quality and care coordination have generally considered care coordination from a single domain or as a binary variable (i.e., coordinated or not). Without a better understanding of what individual care coordination domains can improve care quality and patient rating of care, care coordination interventions may continue to disappoint. A better understanding what aspects of care coordination improve

(or worsen) quality indicators could improve the design of current and future interventions.

In Chapter 3, we use three measures of care coordination, each representing three different domains, to examine the relationship between care coordination and quality of care in a sample of older adults with diabetes and other chronic conditions.

1.2.3. Care Coordination and Health Outcomes

A number of studies have investigated the relationship between care coordination and health outcomes such as emergency room visits, hospitalizations, and preventable hospitalizations. While some studies examining care coordination and these outcomes have reported a positive effect (Coleman et al. 2006; Hussey et al. 2014; Nyweide et al. 2013; Wasson et al. 1984), others have reported no effect or inconsistent results (Brown et al. 2008; Coleman et al. 2001).

There is some evidence that care coordination is associated with better outcomes in patients with chronic conditions. A randomized control trial conducted in the Veterans Administration found that men receiving enhanced physician visit continuity had fewer days in the hospital (Wasson et al. 1984). A recent cross-sectional study by Hussey and colleagues found that greater continuity of care was associated with lower probability of any hospitalization and lower health care spending among Medicare fee for service beneficiaries with congestive heart failure, chronic obstructive pulmonary disorder, and diabetes (Hussey 2014). Nyweide and colleagues using time-dependent survival models report that greater continuity of care was associated with lower risk of a preventable hospitalization in the traditional Medicare population, but higher risk of a preventable hospitalization in patients with chronic obstructive pulmonary disorder (Nyweide et al.

2013). Studies of continuity of care in children have also reported a positive relationship (Christakis et al. 2001; Christakis et al. 1999).

While it has been recommended that care coordination interventions should be targeted in patients with multiple chronic conditions, patients who are most likely to experience fragmented care, there is limited evidence as to whether care coordination is effective in these complex patients. These studies have not examined whether the relationship between care coordination and health outcomes varies by level of morbidity. We examine this issue in Chapter 4 using a pre-post study design examining the relationship between baseline continuity of care and health outcomes.

1.3. Study Context

This thesis examines the care coordination experiences of patients enrolled in a Medicare Advantage plan, Care Improvement Plus. About 25 percent of Medicare beneficiaries are enrolled in the Medicare Advantage program (Linehan 2013). The Medicare Advantage program offers Medicare beneficiaries an alternative to the traditional Medicare program.

In 2003, Congress created Medicare Advantage Special Needs Plans (SNPs) to incentivize private managed care organizations to enroll high-cost, vulnerable beneficiaries who might benefit from specialized services and care coordination. Special Needs Plans are allowed to limit their members to individuals with severe or disabling chronic conditions, individuals eligible for Medicare and Medicaid, and people who are institutionalized. As of January 2011, SNPs account for nearly 1.2 million beneficiaries (Centers for Medicare and Medicaid Services 2011). There are 92 different plans that

focus on patients with a severe or disabling chronic disease. Sixty-two percent of these plans focus on people with diabetes.

SNPs, especially Chronic Care SNPs (C-SNPs), are well-positioned in the Medicare program to improve care for people with multiple chronic conditions. Each plan integrates a health insurance benefit that includes additional care coordination services targeted to their patient population. SNPs are required to provide their members with evidence-based care management services. Care Improvement Plus has implemented interventions including an annual house call, diabetes disease management, telephonic medication reconciliation and counseling, and transitional care (Cohen et al. 2012). Member eligibility for these services varies by the program. For example, a hospitalization will trigger the post-hospitalization follow up program. The patient's assessed risk as measured by modified Medicare's Hierarchical Condition Categories (HCC) scores triggers a pharmacist intervention. All patients are eligible for the annual house call. Similarly, all patients with diabetes are eligible for diabetes disease management services.

There are few evaluations of the Medicare Advantage Special Needs Plan program. One study, comparing hospitalizations in Care Improvement Plus to the Medicare fee for service population, reported that SNP plan members had lower rates of hospital use, hospital readmissions, and higher rates of physician visits (Cohen et al. 2012). We are not aware of any studies examining the association of care coordination with quality of care and health outcomes within a SNP.

1.4. Plan of Dissertation

The subsequent chapters of this dissertation examine the nature of care coordination in older adults with multiple chronic conditions.

Successful care coordination interventions may require complex targeting algorithms, coordinated medical practices, community resources, and patient self-management. It is difficult to measure these disparate components using a single indicator. Most commonly used care coordination performance indicators rely on care outcomes. Focusing on a single measure, ignores other care coordination processes and therefore may not be sensitive to the totality of care coordination's effect. Drawing on a pool of care coordination measures collected through a patient survey and administrative claims data, Chapter 2 examines the underlying domains of care coordination using exploratory factor analysis. We find that care coordination includes three domains: informational continuity between clinicians, information flow to the patient, and continuity of care. We propose that policymakers should consider comprehensive assessing care coordination program performance on all dimensions to ensure a balanced approach to care and the best outcomes.

In Chapter 3, we examine the relationship between different dimensions of care coordination and quality of care in older adults with multiple chronic conditions. We use survey weighted multivariate logistic regression models to examine the association of care coordination measures of informational continuity between clinicians, information flow to the patient, and continuity of care with measures of technical quality of care and patient rating of care. We find a strong, positive relationship between informational continuity between clinicians and patient rating of care. These results suggest that

Medicare and private health plans can improve patient experiences would be to incentivize physicians to communicate with each other about patient care.

Chapter 4 examines whether higher levels of continuity of care at baseline are associated with lower risk of subsequent adverse events. Based on the literature, we would expect that the benefits of care coordination increase with the number of doctors a patient involved in their care. However, there is limited evidence on the relationship between care coordination and adverse outcomes in patients with multiple chronic conditions. Using a pre-post design, we use multivariate logistic regression models to investigate whether baseline continuity of care is associated with adverse events in a subsequent period. We find that continuity of care may have limited benefit in the most complex patients, but is associated with lower odds of a preventable hospitalization in patients with five or fewer chronic conditions.

Chapter 5 summarizes the findings and discusses the limitations and strengths of each study. We conclude with the policy implications and future areas of research.

1.5. Appendix: Hopkins Chronic Care Survey

Diabetes Care

1. Has a doctor ever told you that you have diabetes?

[1]☐ Yes
[2]☐ No → **If No, go to #9.**

These next few questions ask about your diabetes care:

2. In the past year has a doctor or other health care professional including your HouseCalls nurse practitioner examined your feet for sores or irritations?

[1]☐ Yes
[2]☐ No

3. Do you take insulin to manage your diabetes?

[1]☐ Always
[2]☐ Usually
[3]☐ Sometimes
[4]☐ Never

4. Do you test your blood sugar or glucose?

[1]☐ Always
[2]☐ Usually
[3]☐ Sometimes
[4]☐ Never

5. Do you check for sores or irritations on your feet?

[1]☐ Always
[2]☐ Usually
[3]☐ Sometimes
[4]☐ Never

6. Do you measure your blood pressure at home?

[1]☐ Always
[2]☐ Usually
[3]☐ Sometimes
[4]☐ Never

7. Living with diabetes can be hard. Right now, is **worrying about the future and the possibility of serious complications** a problem for you? Is it a:

[1]☐ Serious problem
[2]☐ Somewhat serious problem
[3]☐ Moderate problem
[4]☐ Minor problem
[5]☐ Not a problem

8. Over the past 6 months, when receiving care for your diabetes, were you satisfied that your care was **well organized**?

[1]☐ Always
[2]☐ Usually
[3]☐ Sometimes
[4]☐ Never

Your Doctor

9. Is there a doctor or place that you usually go if you are sick or need advice about your health?

[1]☐ Yes (Please give name.)
[2]☐ No → **If No, go to #16.**

Please print name of doctor or place:

_____

Please think of this doctor or place to answer questions about your doctor.

10. How long have you been going to your doctor?

- [1] ☐ Less than 6 months
- [2] ☐ 6 months to 1 year
- [3] ☐ 1 year to 3 years
- [4] ☐ 3 years to 5 years
- [5] ☐ 5 years or more

11. What is your doctor's specialty?

- [1] ☐ General practice
- [2] ☐ Family physician
- [3] ☐ Internal medicine
- [4] ☐ Cardiologist
- [5] ☐ Endocrinologist
- [6] ☐ Nurse practitioner
- [7] ☐ Physician's assistant
- [8] ☐ I don't know
- [9] ☐ Other

12. About how long does it usually take for you to get to your doctor?

- [1] ☐ 0-15 minutes
- [2] ☐ 16-30 minutes
- [3] ☐ 31-45 minutes
- [4] ☐ 46-60 minutes
- [5] ☐ 1-2 hours
- [6] ☐ More than 2 hours

13. Do you think your doctor has a **complete understanding** of the things that are wrong with you?

- [1] ☐ Yes
- [2] ☐ No

14. In the last 6 months, when your doctor ordered a blood test, x-ray or other test for you, how often did someone from your doctor's office **follow up t**o give you those results?

- [1] ☐ Always
- [2] ☐ Usually

[3] ☐ Sometimes
[4] ☐ Never
[5] ☐ Not Applicable

15. Does your doctor **give you a written plan or instructions** to help you manage your own care at home?

[1] ☐ Always
[2] ☐ Usually
[3] ☐ Sometimes
[4] ☐ Never

Your Last Visit with a Specialist

16. Specialists are doctors like psychiatrists, heart doctors, skin doctors, and others who specialize in a particular area of health care.

In the last 6 months, did you receive care from any specialists outside your doctor's office?

[1] ☐ Yes
[2] ☐ No → **If No, go to #20.**

These questions ask about your **last visit** with a specialist:

17. Do you think this specialist knew all of the **medications** you were taking?

[1] ☐ Yes
[2] ☐ No

18. Do you think this specialist has a **complete understanding** of the things that are wrong with you?

[1] ☐ Yes
[2] ☐ No

19. Did this specialist **give you a written plan or instructions** to help you manage your own care at home?

[1] ☐ Yes
[2] ☐ No

Your Health Care in the Last 6 Months

20. Does the Care Improvement Plus nurse you speak with on the phone play an **important role** in your care?

1☐ Yes
2☐ No
3☐ Not applicable

21. Does the Care Improvement Plus pharmacist you speak with on the phone play an **important role** in your care?

1☐ Yes
2☐ No
3☐ Not applicable

Thinking about **all doctors, nurses and other health care providers** you see:

22. In the last 6 months, **not** counting the times you went to an emergency room, how many times did you go to a doctor's office or clinic to get health care for yourself?

☐ None → **If None, go to #27.**
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5 to 9
☐ 10 or more

23. How often does one of your family members or friends come into the exam room with you for your doctors' visits?

1☐ Always
2☐ Usually
3☐ Sometimes
4☐ Never

24. In the past 6 months, has any doctor given you **instructions for one of your conditions that conflicted** with what you have been told to do for another condition?

[1] ☐ Always
[2] ☐ Usually
[3] ☐ Sometimes
[4] ☐ Never
[5] ☐ Not Applicable

25. In the last 6 months, how often did **your doctor seem informed and up-to-date** about the care you received from specialist physicians?

[1] ☐ Always
[2] ☐ Usually
[3] ☐ Sometimes
[4] ☐ Never
[5] ☐ Not Applicable

26. In general, do you think the doctors you see **communicate** with each other about your care?

[1] ☐ Always
[2] ☐ Usually
[3] ☐ Sometimes
[4] ☐ Never
[5] ☐ Not Applicable

Your Last Hospital Stay

27. Were you admitted to a hospital in the last 6 months?

[1] ☐ Yes
[2] ☐ No → **If No, go to #30.**

The following questions ask about **the last time** you stayed overnight at this hospital.

28. Did you leave the hospital with a readable and easily understood **written list** of the appointments or tests you needed to complete within the next several weeks?

[1] ☐ Yes
[2] ☐ No

29. Did you leave the hospital confused about exactly what **medicine to take** when you got home?

[1] ☐ Yes
[2] ☐ No

Your Last Emergency Room Visit

30. Have you gone to the emergency room in the last 6 months?

[1] ☐ Yes
[2] ☐ No → **If No, go to #33.**

The following questions ask about the **last time** you went to the emergency room.

31. When you left the emergency room, did you receive a **written list** of what care you received?

[1] ☐ Yes
[2] ☐ No

32. Did you leave the emergency room confused about exactly **what medicine** to take when you got home?

[1] ☐ Yes
[2] ☐ No

Overall Rating

33. Overall, how do you rate the **quality** of medical care that you have received in the past 12 months?

[1] ☐ Excellent
[2] ☐ Very good
[3] ☐ Good
[4] ☐ Fair
[5] ☐ Poor

34. In the past 12 months, how often did you feel **your time** was wasted because your medical care was poorly organized?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

Your Health

35. In general, how would you rate your **overall health**?

1☐ Excellent
2☐ Very good
3☐ Good
4☐ Fair
5☐ Poor

36. In general, how would you rate your health **compared to one year ago**?

1☐ Much better
2☐ Somewhat better
3☐ About the same
4☐ Somewhat worse
5☐ Much worse

37. Over the last two weeks, how often have you been bothered by having little interest or pleasure in doing things?

1☐ Nearly every day
2☐ More than half the days
3☐ Several days
4☐ Not at all

38. Over the last two weeks, how often have you been bothered by feeling down, depressed, or hopeless?

1☐ Nearly every day
2☐ More than half the days
3☐ Several days
4☐ Not at all

BACKGROUND

39. What is the highest grade or level of school that you have completed?

- [1] ☐ 8th grade or less
- [2] ☐ Some high school, but did not graduate
- [3] ☐ High school graduate or GED
- [4] ☐ Some college or 2-year degree
- [5] ☐ 4-year college graduate
- [6] ☐ More than 4-year college degree

40. Which of the following best describes your racial or ethnic background? (Please check only one box)

- [1] ☐ Hispanic or Latino
- [2] ☐ White
- [3] ☐ Black or African-American
- [4] ☐ Asian
- [5] ☐ Other

41. What was your household income last year?

- [1] ☐ Less than $10,000
- [2] ☐ $10,000 to $24,999
- [3] ☐ $25,000 to $49,999
- [4] ☐ $50,000 to $79,999
- [5] ☐ $80,000 or more

42. What is your current marital status?

- [1] ☐ Married
- [2] ☐ Separated
- [3] ☐ Divorced
- [4] ☐ Widowed
- [5] ☐ Never been married

43. Did someone help you complete this survey?

- [1] ☐ Yes
- [2] ☐ No → **If No, go to #45**

44. How did that person help you? Mark all that apply.

[1] ☐ Read the questions to me
[2] ☐ Wrote down the answers I gave
[3] ☐ Answered the questions for me
[4] ☐ Translated the questions
[5] ☐ Helped in some other way

45. Did you complete this survey for someone else?

[1] ☐ Yes
[2] ☐ No

– END –

Thank you for helping us today.

Please return the completed survey in the postage-paid envelope or send to:

DSS Research ● P.O. Box 985009

Ft. Worth, TX 76185-9976

If you have any questions, please call 1-800-989-5150, ext. 4156.

Chapter 2: Preliminary Validation of Care Coordination Measures in Older Adults with Multiple Chronic Conditions

2.1. Abstract

Background: Successful care coordination interventions may require complex targeting algorithms, coordinated medical practices, community resources, and patient self-management. It may be difficult to measure these disparate components using a single indicator. Most commonly used care coordination performance indicators rely on outcome measures, which do not measure all these facets of care coordination, and therefore may not be sensitive to the totality of care coordination's effect.

Objective: To identify a few questions or claims data indicators that captures the multidimensional nature of care coordination.

Study Design: Cross-sectional patient survey with purposive sampling of older adults with multiple chronic conditions was linked to administrative claims data. Principal component, factor, and internal consistency analyses were performed to identify the dimensions of care coordination and used to select representative measures from each dimension.

Subjects: 758 older adults with diabetes and other chronic conditions enrolled in a Medicare Advantage Chronic Care Special Needs Plan in Arkansas, Georgia, Missouri, South Carolina, and Texas.

Results: We find three measures of care coordination capture the main dimensions of care coordination and have adequate internal validity: the Usual Provider of Care Index, and two survey questions – *In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians* and *Does your doctor give you a written plan or instructions to help you manage your own care at*

home should be considered for use in assessing care coordination programs. Claims-based care coordination measures capture a different dimension of care coordination from patient survey measures.

Conclusion: We identify three measures that in combination can be used to assess patient experiences of care coordination in older adults with multiple chronic conditions. Evaluations of care coordination programs should consider using both claims-based and patient survey measures in order to comprehensively assess care coordination programs.

2.2. Introduction

Care coordination is considered integral to the efficient and effective delivery of health care for older adults, especially for older adults with multiple health conditions who use many different clinicians across multiple settings of care (National Quality Forum 2012b). As Medicare and other insurers use a combination of financial rewards and penalties to promote care coordination, how the quality of care coordination will be measured is important (Fagan et al. 2010; Thorpe and Ogden 2010). It is well established that financial incentives can affect medical practice and so it is critical for the measures to cover all relevant dimensions in order to encourage appropriate responses. Care coordination performance measures could also provide important information to clinicians and insurers on provider performance and patient experiences, and eventually informing pay-for-performance programs and physician report cards. Most importantly, it could help patients with multiple chronic conditions get the care that they need.

Despite a substantial literature on care coordination and its relevance to key subgroups, there are few actual care coordination performance measures (National Quality Forum 2012a). There are two basic data sources for evaluating programs: administrative claims data and survey data. Many care coordination program evaluations rely on claims based measures because the data is readily accessible (Brown et al. 2008; Dugoff et al. 2013). While more costly to collect, the advantage of patient survey data is that it collects information from the patient's perspective on how well his or her care is actually organized. Donabedian argued that the "ultimate validators of the effectiveness and quality of medical care" are measures taken from the patient's point of view (Donabedian 2005). Previous studies have found that patient reported care coordination

to be related to better quality of care, patient satisfaction, and health care utilization (Adler, Vasiliadis, and Bickell 2010; Cabana and Jee 2004; Gulliford, Naithani, and Morgan 2007; Maeng et al. 2012). Several studies have examined either the nature of claims-based measures of care coordination (Bentler et al. 2013; Brown et al. 2008; Van Walraven et al. 2010; Wolinsky et al. 2009) or survey-based measures (Gulliford, Naithani, and Morgan 2006; Haggerty et al. 2012; Singer et al. 2012). However, the relationship between claims-based care coordination and survey measures has received much less attention (Bentler et al. 2013).

Care coordination interventions require complex targeting algorithms, coordinated medical practices, community resources, and patient self-management. It is difficult to measure these disparate components using a single measure. Yet, the success of care coordination programs are often measured by a single indicator such as whether the program reduces preventable hospitalizations or readmissions (Brown et al. 2008; Dugoff et al. 2013). While these outcomes may be affected by poor care coordination, recent studies suggests that a relative small proportion of hospitalizations and readmissions are actually preventable (Gorodeski et al. 2010; Joynt and Jha 2012; van Walraven et al. 2011), suggesting that the ability for care coordination interventions to show marked improvement in these outcomes may be limited. In addition, claims-based measures provide little feedback on what specific aspects of care coordination are working and what activities need to be improved. Care coordination performance measures that assess the multidimensional nature of care coordination programs and their performance could provide important information to evaluators about what aspects of these programs are working and what aspects need improvement.

The objective of this study is to identify the underlying domains of care coordination. Using indicators drawn from each domain of care coordination to measure care coordination performance could provide useful information to care providers and policymakers about what works in patients with multiple chronic conditions. The goal is to find one measure that best represents each of the different dimensions of care coordination. For policymakers and clinicians, a single item from each dimension may be easier to understand and act upon, compared to a scales which are more challenging to interpret. For evaluators, collecting a few measures that can comprehensively assess program performance can be more efficient and effective.

The National Quality Forum (NQF) considers a number of key pieces of evidence when reviewing potential performance measures from the measure's strength of the measure's evidence base including reliability and validity, applicability to key populations, and feasibility and usability (National Quality Forum 2013). While not all criteria are the same, these criteria are similar to those identified by the National Quality Measure's Clearinghouse and those recommended by experts in quality and performance measurement (McGlynn and Asch 1998; Shekelle 2013; Stelfox and Straus 2013). In this study, we focus on the issue of internal validity, which is agreed to be fundamental for a performance measure, and discuss measure performance for other NQF criteria.

2.3. Methodology

2.3.1. Analytic Approach

There are a number of steps necessary in order to identify potential measures of care coordination quality. First, we developed a conceptual framework of care coordination based on the literature. We then identified a pool of potential measures

based on previous systematic reviews of the literature. We organized potential measures according to our conceptual framework to ensure adequate representation of each domain. Next, for data collection we selected measures demonstrating face and content validity that represented each care coordination domain. Following data collection, we then examined the underlying domains of care coordination and internal construct validity using exploratory factor analysis. While this study used a conceptual framework to guide measure selection, the exploratory factor analysis was used to examine the underlying domains of care coordination de novo. Below we discuss each step in more detail.

2.3.1.1. Care Coordination Framework

Based on a systematic review of the literature, Kathryn McDonald and colleagues defined care coordination from the patient perspective as: "Care coordination is any activity that helps ensure that the patient's needs and preferences for health services and information sharing across people, functions, and sites are met over time (McDonald et al. 2010)." There are other definitions of care coordination that focus on provider activities or the health system perspective. McDonald's definition from the patient perspective is helpful because it considers activities that can be provided by health care providers, other service providers, as well as family members. Based on previous work by Jeannine Haggerty and Sara Singer, we view care coordination as including five main components: information sharing (informational continuity), which includes information sharing between clinicians as well as information flow to the patient; relationships with one or more providers over time (longitudinal continuity); and, a consistent approach to the patient's health care needs (management continuity), which includes coordination

activities provided by the patient's usual source of care as well as coordination activities by specialists (Haggerty et al. 2003; Reid, Haggerty, and McKendry 2002; Singer et al. 2011). We used this framework to categorize potential patient survey and claim-based care coordination measures previously published in the literature (Table 2-1).

2.3.1.2. Survey Measure Selection

Potential survey items were collected through a review of nine surveys: the Medicare Current Beneficiary Survey, Consumer Assessment of Healthcare Providers and Systems (CAHPS) Clinician & Group Survey, Primary Care Assessment Tool, Patient's Perspective on Integrated Patient Care, and Commonwealth Fund's International Health Policy Survey of Sicker Adults questionnaire, Medicare Health Outcomes Survey, Care Transitions Measure, and the Medicare Advantage Special Needs Plan's consumer satisfaction survey (Agency for Healthcare Quality and Research 2011; Coleman et al. 2002; National Committee for Quality Assurance 2010; Office of Research 2010b, 2010a, 2010c; Schoen et al. 2008; Shi et al. 2001; Singer et al. 2011).

Through this process, 136 items representing each of the three primary dimensions (informational continuity, longitudinal continuity, and management continuity) were identified. The intention was to ask a limited number of questions in each dimension to minimize the burden on survey subjects. In order to reduce the number items on the survey, experts in survey development at Hopkins and the Medicare Advantage Special Needs Plan were consulted on item wording, redundancy, and content. Items were removed if they were redundant or poorly articulated. The survey items were refined through expert review and cognitively tested in four older adults. Following cognitive testing, we made further modifications to simplify language and clarify the

survey instructions. The final survey included a total of 45 questions: 17 items relevant to the dimensions of care coordination, nine items about care quality and utilization, five items about diabetes self-care, five items about health status, and seven items about demographic characteristics. The survey instrument is available in the Appendix.

2.3.2.Claims Measures Selection

Potential measures were identified using four reviews of care coordination measures (Jee 2006; Saultz 2003; Smedby et al. 1986; Van Walraven et al. 2010). Based on these reviews, we identified 21 potential measures and then categorized them according to the study's initial conceptual framework. Measures that could not be constructed with the available study data timeframe (e.g., longitudinal measures) were eliminated. We then selected the two most frequently used measures from each category. Measures categorized as coordination with one's usual source of care were measures of care concentration: the Usual Provider of Care Index and Herfindahl Index. Measures quantifying the dispersion of care across providers (Continuity of Care Index and Sequential Continuity) represented coordination with specialists. Measures assessing number of providers, a measure of the opportunities for informational continuity breakdowns, and concentration in care across physician practices (Site of Care) represented informational continuity between clinicians.

2.3.3. Study Sample

All study subjects were members of a Medicare Advantage Chronic Care Special Needs Plan. In order to be included in the study, a health plan member had to be at least 65 as of January 1, 2010, be enrolled in a plan in Arkansas, Georgia, Missouri, South Carolina, or Texas, and be identified as having diabetes and at least one other chronic

condition. After stratifying by number of chronic conditions, individuals were selected randomly within strata. This approach over-sampled people with multiple chronic conditions. The sampling approach did not consider other factors such as sex or state of residence.

2.3.4. Survey Data Collection

The survey instrument was distributed and the data collected by a third-party research firm. A two-stage mailing strategy was used to maximize survey response. The survey was first mailed to subjects on July 2011 with a $5 incentive payment. A second survey packet was sent to non-responding subjects four weeks later. The survey was distributed to 1,600 eligible plan members of whom 21 died during the study period and were therefore excluded. Of the eligible 1,579 subjects, 758 responded (response rate = 48 percent).

2.3.5. Claims Data Collection

The claims based care coordination measures were constructed using administrative claims data from July 1, 2010 to September 30, 2011. Unique physicians were determined using the National Provider Identifier (NPI) provided on physician claims. Multiple claims occurring on the same date for the same physician NPI were considered to be a single visit. Each physician NPI was classified assigned the plurality specialty according to the billed provider specialty codes, then classified as a primary care physician, medical specialist, surgeon, or emergency room physician according to the approach described by Pham and colleagues (Pham et al. 2007). Physicians with limited responsibilities for patient care including anesthesiologists, radiologists, and pathologists were excluded. A primary care visit was defined as an evaluation and

management (E&M) visit as described in Pham and colleagues (2007). The primary provider was defined as the physician who provided the plurality of the patient's primary care visits. A physician visit included any outpatient physician claim billing for an evaluation and management or procedure code. A site of care was defined as a unique billing tax identification number.

Care coordination measures were created using standard algorithms described in the literature (Table 2-2) (Jee 2006). Care coordination measures are unstable or nonsensical for individuals with only a few outpatient visits. For example, by definition a person with two visits could have a score of 0 or 1 on the COC index, UPC index, and SECON. For this reason, we limit our analysis to individuals with three or more primary care visits, which is consistent with previous studies (Christakis et al. 2001; Liss et al. 2011). Consistent with previous studies, we categorize the claims-based measures by tertiles into low, middle, and high levels of coordination.

2.3.6. Statistical Analysis

All analyses were conducted in Stata version 12 (StataCorp 2011). Survey and item non-response are assessed to explore potential response bias. Respondents and non-respondents are compared based on administrative characteristics. Meaningful differences between respondents and non-respondents were determined using chi-square tests for categorical variables. Factor analysis relies on inter-item correlation, and as a result items with insufficient variation or strong correlation with other measures can create unstable estimates. Therefore, we examined ceiling and floor effects by assessing responses in the most positive (top box) and most negative categories (bottom box). The distribution and inter-item correlation of claims based measures were examined

separately. We expected that measures with substantial missing data, exhibiting floor or ceiling effects (>75% in any one category), and inter-item correlations greater than 0.9 could unduly affect the analysis and were excluded.

The objective is first to identify the dimensions present in the data using exploratory factor analysis, then determine using domain communality if a single indicator can be identified as representative of its dimension.

Exploratory factor analysis was used to explore the observed latent structure of the care coordination items. Principal component analysis (PCA) uses the observed variance to identify clusters of related items, called components (Pett, Lackey, and Sullivan 2003). To account for the ordinal nature of the claims-based and survey measures, PCA was conducted on the polychoric correlation matrix (StataCorp 2011). Tetrachoric correlation matrices are most appropriate for binary variables and Pearson correlation matrices for continuous variables. The number of distinct factors was determined by examining the scree plot (Pett et al. 2003). *Factormat* was used to extract each factor using maximum likelihood and promax (oblique) rotation. Oblique rotation allows the extracted factors to be correlated. A common problem in maximum likelihood factor analysis is the occurrence of a Heywood case; that is, an item is estimated to have a communality greater than one or negative error variances (Dillon, Kumar, and Mulani 1987). These cases can occur when the true population value is close to a boundary such as 0 or 1, overfitting (i.e., trying to extract too many factors), and model misspecification. We followed Dillon and Kumar's advice (1987) for Heywood cases: first, we selected different start values for the maximum likelihood maximization; second, we assessed model specification, finally, we selected fewer factors. In the rotated factor analysis,

items with substantial factor loadings (>0.4) on any single factor were considered meaningful.

Patient-level scores for each dimension were created as the sum of the each measure in the scale. Because not all items have the same response scale, items scores were standardized with mean 0 and variance 1 before summing.

In the main analysis, subjects missing responses on any care coordination measure were excluded. In a sensitivity analysis, we imputed missing survey responses using chained equations (Royston 2005) and conducted the factor analysis using all 758 survey respondents. We also examined the robustness of the main results by conducting the principal component analysis separately on the survey and claims-based measures of coordination.

2.3.6.1. Face and Content Validity

Face and content validity assesses how well the item reflects it's underlying construct. Face validity is an assessment of the item "on its face" based the measure's wording and content. Often, face validity is assessed by subject matter experts. Content validity compares the subject of the item with the content of the underlying construct. In this study, we examine whether the measures correspond to expected care coordination identified for measure selection (Haggerty et al. 2003; Singer et al. 2011; Singer et al. 2012).

2.3.6.2. Internal Construct Validity

An item exhibits good construct validity when there is concordance between its hypothesized nature and observed properties. In this study, we assess the construct validity by examining the whether the items' factor loadings cluster on the expected

dimensions of care coordination, internal consistency reliability coefficient as measured using Cronbach's α, and correlation with other factors. Our expectation is that care coordination dimensions will be moderately correlated and there will be discrimination between dimensions.

2.3.6.3. Representative

The objective of this study is to identify a single measure from each dimension of care coordination that best predicts its care coordination dimension. To identify potential measures, we examined the communalities of all items from the factor analysis. Commonality is the proportion of the variable's variance that is explained by its factors. Commonality was calculated as the square of the factor loading. Items with the largest commonality were considered more representative of its dimension.

2.4. Results

2.4.1. Sample Characteristics

Table 2-3 examines study subjects by survey response. Respondents and non-respondents were similar on gender, race, age, original reason for Medicare eligibility (age, disability, or end-stage renal disease), and Medicaid status. Because the survey sampling strategy over-sampled individuals with multiple chronic conditions, the results show that nearly 80% of respondents and non-respondents had more than five chronic conditions. A greater proportion of non-respondents had 11 or more chronic conditions than survey respondents (43.5% versus 39.7%). While respondents and non-respondents had similar proportion of individuals with at least one reported activities of daily living limitation (12.9% compared to 15.6%), there were differences in missing data: only 8.6%

of respondents had missing data compared to 17.9% of non-respondents had missing data.

The study sample included 347 survey subjects with no missing data. Appendix Table 2-1 presents their characteristics compared to excluded survey respondents and all survey respondents. Members of the study sample were more likely to have 11 or more chronic conditions, less likely to be enrolled in Medicaid, and less likely to speak Spanish than excluded subjects. Study subjects were similar to excluded subjects in terms of age, original reason for Medicaid eligibility, and presence of activities of daily living.

2.4.2. Care Coordination Measure Characteristics

The care coordination survey item responses and the percentage of responses in the most positive category (top box) and the lowest category (bottom box) are presented in Table 2-4. In general, we found that that item response rates were higher on questions listed earlier in the survey with the exception being that 96% of survey respondents answered Q35. Only one-third of respondents reported hospitalization and emergency department use in the past six months resulting in fewer responses than expected.

Eight items exhibited ceiling effects where more 75% of responses were in the highest response category. All of these items used a dichotomous response scale (yes or no). These items covered topics about coordination by the usual source of care coordination by specialists, and four items on transitions from the hospital and emergency room also exhibited ceiling effects. These eight survey items were excluded from the analysis because items with little variation can lead to unstable estimates.

The care coordination measure distributions and correlations are presented in Table 2-5. All care coordination measures exhibit moderate to high correlation ranging

from 0.45 to 0.98. The COC Index and Herfindahl Index were highly correlated (r=0.98). We excluded the Herfindahl Index from the principal component analysis because it is used less frequently in the literature.

Figure 2-1 presents a diagram illustrating the measure selection process. A summary of the measures and their respective dimension at data collection and after the exclusions following exploratory data analysis are presented in Table 2-6. After the exploratory data analysis, 14 measures (5 claims-based measures and 9 survey measures) were eligible for the factor analysis. These measures represent all five dimensions of care coordination.

2.4.3. Exploratory Factor Analysis

According to the scree plot, a three-factor model best fit the data. Two dimensions from our conceptual framework, coordination by the usual source of care and coordination by specialists, were not distinct dimensions. All claims-based measured, which primarily represented these two dimensions, loaded onto a single factor, *continuity of care* of which the UPC Index was the most representative measure. Another dimension, longitudinal continuity, was not identified. The survey measures were divided between two dimensions: *information continuity between clinicians* and *information flow to the patient*. In these dimensions, Q26 "In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?" and Q15, "Does your doctor give you a written plan or instructions to help you manage your own care at home?" accounted for the greatest amount of the variation in its domain.

The scree plot of the PCA results indicated there were three distinct components (Figure 2-2). The first three components accounted for 59% of the total observed

variance. Table 2-7 presents the rotated factor loadings and the proportion of explained variation (communality). Meaningful factor loadings, those with values >0.4 are in bold. We did not observe any cross-loadings greater than 0.4 for any item. One survey item, Q10, which asked how long the patient had been seeing his or her usual source of care, did not have any significant factor loadings. One reason Q10 may not have had any significant factor loadings is because it was the only measure thought to capture longitudinal continuity.

Table 2-8 presents the internal reliability scale coefficient and correlations between each derived dimension scale. Overall, all three factors exhibit reasonable internal consistency. The standard threshold for excellent internal consistency is $\alpha>0.7$ (Streiner and Norman 2008). The care continuity dimension has the largest reliability coefficient, 0.83 while information flow to the patient exhibited adequate reliability, $\alpha=0.70$. The inter-scale correlations indicate little correlation between continuity of care and the dimensions measures by the patient survey measures: information flow to the patient and information continuity between clinicians.

A single measure from each dimension with the largest community was selected for to assess its predictive ability (Table 2-7, column 4). For the first domain which we call continuity of care, the measure with the largest communality was the Usual Provider of Care Index (Communality = 0.74). For the second domain which we call information flow to the patient, the measure with the largest communality is Q15, “Does your doctor give you a written plan or instructions to help you manage your own care at home?” (Communality = 0.71). In the third domain, which we call informational continuity between clinicians, the measure with the largest communality was Q25, “In the last 6

months, how often did your doctor seem informed and up-to-date about the car you received from specialist physicians?" (Communality = 0.71).

We conducted a number of planned sensitivity analyses. We conducted the PCA on the claims-based and survey measures separately. When analyzed separately, the scree plot analysis (Appendix Figure 2-1) identified one factor of claims-based measures and two factors of survey measures reinforcing the results of the three domain results of the main analysis

We also tested the sensitivity of these findings to the complete case analysis. We used multiple imputation to generate values for missing survey responses based on available patient level characteristics including age, race, marital status, income, survey responses, health status, and medical care utilization. The factor analysis results are presented in Appendix Table 2-2. Consistent with the main analysis the principal component analysis identified the same three distinct components that accounted for 60% of the total observed variance. The promax rotated factor leadings yielded somewhat different results from the main analysis. For *information flow to the patient* Q19, "Did this specialist give you a written plan or instructions to help you manage your own care at home?" the most representative. In the main analysis, Q15, "Does your doctor give you a written plan or instructions to help you manage your own care at home?" was found to be the most representative.

2.5. Discussion

Three measures can be used to assess three dimensions of care coordination in older adults with multiple chronic conditions: the Usual Provider of Care (UPC) Index captures continuity of care; "Does your doctor give you a written plan or instructions to

help you manage your own care at home" assesses information flow to the patient; and "In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians" evaluates information continuity between clinicians. This study finds that claims-based measures of care coordination are orthogonal to patient-reported survey measures. Evaluations that only use claims-based measures of care coordination will not capture important dimensions of care coordination identified in this study: information flow to the patient and information continuity between clinicians. Failure to account for the multidimensional nature of care coordination may lead to incomplete program evaluations. At worst, pay for performance programs focusing on either claims or patient survey measures may create perverse incentives driving providers away from providing comprehensive care coordination, which could have adverse effects on the patients who most need these services, patients with multiple chronic conditions.

This study examines a pool of care coordination measures exhibiting good face and content validity. Statistical tests were then administered to identify the underlying dimensions and select an indicator that was representative of each dimension. Based on our review of the literature, we had identified five dimensions of care coordination for measure selection. The factor analysis identified three of the expected five dimensions.

Based on the literature, the claims-based care coordination measures were thought to capture three distinct dimensions. These findings suggest these measures capture a single dimension, which we call continuity of care. Previous studies in the Medicare fee for service population and a study in Sweden also found similarly high inter-item correlations between these and similar measures (Bentler et al. 2013; Pollack et al. 2013;

Smedby et al. 1986). While some of these measures were constructed to measure concentration of care with certain providers and others created to measure dispersion of care across providers, these measures may be two sides of the same coin, at least in patients with multiple chronic conditions who have relationships with multiple providers, and as such were found to be the same dimension of care coordination.

Among the patient survey measures, all but two measures loaded the assigned dimensions from measure selection. Question 35, "In the past 12 months, how often did you feel your time was wasted because your medical care was poorly organized" was categorized during measure selection as assessing coordination by the usual source of care, but loaded onto informational continuity between clinicians. It is reasonable that this item assesses aspects of how well information is communicated within a clinician's office and between the clinician's office and other providers which reflects information continuity between providers. One item, Q10 assessing the duration of the patient's relationship with his or her usual source of care, did not load onto any of the extracted factors. This result is consistent with the conceptual framework classifying Q10 as measuring longitudinal continuity. In future analyses, it may be important to assess longitudinal continuity using additional measures to identify if it is a meaningful dimension of care coordination.

Consistent with recent studies of the care coordination construct, these findings suggest care coordination is a multidimensional construct, and claims-based measures and patient survey measures are orthogonal (Bentler et al. 2013; Haggerty et al. 2012; Singer et al. 2012). This study extends the field by directly examining whether patient survey data and claims-based measures measure similar dimensions of care coordination.

Our findings differ from Bentler and colleagues in the exact number of claims-based care coordination dimensions, however, this is not surprising given differences in the number of measures evaluated, sample size, and differences in methodological approach. That said, the inter-item correlations between claim-based care coordination measures are very similar between the two studies.

In recent years, Medicare and private health insurers have made substantial investments in care coordination programs. In these programs, it is important for policymakers and health insurers to consider not only which program lowers hospital readmissions or health care costs, but also to identify what aspects of these programs worked well or were associated with better (or worse) outcomes. In addition, performance measures that capture different aspects of care coordination can provide important feedback to providers about not just how well their practice is doing, but how well other providers in the community are doing. Clinicians could also consider incorporating patient survey measures at the point of care to identify potential care coordination problems as early as possible.

The objective of this study was to identify a subset of measures for care coordination programs that capture the multidimensional nature of care coordination. The NQF criteria for considering new performance measures, including the evidence with respect to the measure and important outcomes; its relevance to key populations; the measure's reliability and validity; feasibility and usability; and its performance and relevance in comparison to other similar measures. This study has established the internal validity of these three measures in an important population for care coordination interventions—older adults with multiple chronic conditions. This population accounts

for a disproportionate share of Medicare spending and is more likely to experience breakdowns in care that could lead to adverse outcomes. This study did not compare measures' performance to existing measures in use or to measures of quality of care or health outcomes. Chapter three examines the association of these three measures with commonly used quality of care metrics. Chapter 4 studies the association of one domain, continuity of care, with measures of adverse health outcomes. Additional research is needed to examine the reliability of these measures, external validity, and performance relative to other measures.

Several study limitations should be noted. One, this study does not use a gold standard to assess the validity of claims-based measures of care coordination. While the patient experience is not a gold standard of care coordination, it is an important component (Wasson 2009). An alternative approach would be to use physician surveys or direct observation. In addition, patient experience measures are subject to non-response bias and information bias. It is possible that certain patient experience measures are also subject to confounding by severity and/or factors unrelated to the health care system.

Two, this study does not use a previously validated survey instrument. We sought to minimize construct validity issues by drawing on published survey items. While the survey instrument was largely drawn from previously published surveys, this administration revealed opportunities to improve several items. In particular, survey items about specialist care used a two-level response scale, which yielded ceiling effects. A four-point likert scale could increase variation in responses. In addition, the survey response rate of 47 percent, while adequate, could be improved with additional mail or telephone reminders.

Three, capturing all dimensions of care coordination is a challenge for program evaluators, health plans, and Medicare. This study recommends three measures to fill this gap. While this analysis examined 14 measures of care coordination, we did not identify potentially important dimensions: care coordination by the usual source of care and care coordination by specialists. Additional measures assessing these domains may have generated different results. In future research, one avenue to pursue is collecting patient experiences of specific clinicians, which could help differentiate the actions of the usual source of care from specialists. An alternative interpretation may be that care coordination, from the patient perspective, does not differentiate the actions of one clinician from another because if any one clinician does not coordinate with another, then the patient's care coordination will suffer and increase his or her risk for an adverse event.

Four, we examine a pool of 14 measures of care coordination. Our study did not allow for use of all identified measures and prioritized measures using an a priori conceptual framework. It is possible that the addition of other measures could have identified additional domains. In addition, communality is a measure of the correlation of a measure with the domain, but there is no specific criteria to assert when a communality score is sufficiently high. We apply the same framework that is typically applied to correlation studies where correlation coefficients greater than 0.7 are considered strongly correlated (Streiner and Norman 2008).

Five, additional study is necessary to assess these three measures' reliability over multiple administrations as well as in comparison to other care coordination performance measures. While these measures do require further study, an advantage of these measures

is that they are not disease specific and have been shown to be internally consistent and valid in a sample of older adults with multiple chronic conditions—the group most likely to benefit from care coordination programs.

2.6. Conclusion

While administrative data is an important source of information and relatively low cost, policymakers, providers, and program evaluators should consider also including patient survey measures. This study identifies three care coordination potential performance measures, one claims-based measure and two survey measures that capture different dimensions of care coordination. These measures can be used by providers, policymakers, health insurers, and program evaluators to assess patient experiences on different dimensions of care coordination to capture a broader perspective on what care coordination are doing and could do better.

Table 2-1. Conceptual framework of care coordination for measure selection

Dimensions	Description
1. Coordination by Usual Source of Care	"A consistent and coherent approach to the management a patient's health conditions" by a patient's primary clinician (Haggerty et al. 2003)
2. Coordination By Specialists	"A consistent and coherent approach to the management a patient's health conditions" by a patient's specialist clinicians (Haggerty et al. 2003)
3. Information Continuity Between Clinicians	All care teams communicate with each other to deliver consistent and informed patient care.
4. Information Flow to the Patient	Contact between clinicians and their staff with the patient and family between patient visits (Singer et al. 2011)
5. Longitudinal Continuity	Having an ongoing therapeutic relationship with one or more providers (Haggerty et al. 2003)

Table 2-2. Claims-based care coordination measures

Dimension	Care Coordination Measure	Algorithm
Coordination by Specialists	Bice-Boxerman Continuity of Care Index	$\frac{\sum_{i=1}^{m} n_{ij}^2 - \Sigma\, n_i}{\Sigma\, n_i(\Sigma\, n_i - 1)}$
Coordination by Specialists	Sequential Continuity	$\frac{\sum_{i=1}^{N-1} s_i}{(\Sigma\, n_i) - 1}$
Coordination by Usual Source of Care	Usual Provider of Care Index	$\frac{v_{ij}}{\Sigma\, v_i}$
Coordination by Usual Source of Care	Herfindahl Index	$\sum \left(\frac{d_j}{\Sigma\, n_i}\right)^2$
Information Continuity Between Clinicians	Number of Providers Seen	$\sum d_i$
Information Continuity Between Clinicians	Site Index	$\frac{n_{it}}{\Sigma\, n_i}$

V = Primary Care Visit, D = Physician, N = Physician Visit, S = sequential pairs of visits, i = unique sites of care, i = patient, j = unique physician

Table 2-3. Sample characteristics by survey response

	Respondents	Non-Respondents	Total	P-value
Sample Size (N)	758	821	1,579	
Age (%)				0.469
65-69	23.22	20.71	21.91	
70-79	52.64	53.84	53.26	
>=80	24.14	25.46	24.83	
Race (%)				0.616
White	43.27	42.02	42.62	
Not White	56.73	57.98	57.38	
Gender (%)				0.392
Female	63.59	65.65	64.66	
Male	36.41	34.35	35.34	
Original Reason for Medicare Eligibility (%)				0.607
Age	72.56	73.08	72.83	
Disability	27.44	26.8	27.11	
ESRD	0	0.12	0.06	
Any Limitations in Activities of Daily Living (%)				<0.001
None	78.5	66.5	72.26	
Yes	12.93	15.59	14.31	
Missing	8.58	17.9	13.43	
Language (%)				0.868
English	97.1	96.95	97.02	
Spanish	2.9	3.05	2.98	
Any Medicaid Enrollment (%)				0.275
None	44.85	43.12	44.85	
Yes	55.15	56.88	55.15	
Number of Chronic Conditions (%)				0.080
<6	21.37	23.02	22.23	
6-10	38.92	33.5	36.1	
11+	39.71	43.48	41.67	
State (%)				0.491
Arkansas	7.52	5.48	6.46	
Georgia	32.32	31.55	31.92	
Missouri	5.54	6.46	6.02	
South Carolina	29.95	31.06	30.53	
Texas	24.67	25.46	25.08	

Table 2-4. Patient survey care coordination item response and distribution

Item	Question	Response Format	N	Top Box (%)	Bottom Box (%)
Q8	Over the past 6 months, when receiving care for your diabetes, were you satisfied that your care was well organized?	A/U/S/N	680	71.03	0.59
Q9	Is there a doctor or place that you usually go if you are sick or need advice about your health?	Y/N	662	96.22	3.78
Q10	How long have you been going to your doctor?	Less than 6 months/6 months to 1 year/1 year to 3 years/3 years to 5 years/5 years or more	631	52.77	7.45
Q13	Do you think your doctor has a complete understanding of all the things that are wrong with you?	Y/N	613	94.62	7.50
Q14	In the last 6 months, when your doctor ordered a blood test, x-ray, or other test for you, how often did someone from your doctor's office follow up to give you those results?	A/U/S/N	618	72.82	5.02
Q15	Does your doctor give you a written plan or instructions to help you manage your own care at home?	A/U/S/N	624	48.88	13.62
Q17	Do you think this specialist knew all the medications you were taking?	Y/N	525	97.71	2.29
Q18	Do you think this specialist has a complete understanding of the things that are wrong with you?	Y/N	522	92.72	7.28

* Response coding was reversed such that good care coordination is the reference category.

Table 2-4. Patient survey care coordination item response and distribution (Continued)

Item	Question	Response Format	N	Top Box (%)	Bottom Box (%)
Q19	Did this specialist give you a written plan or instructions to help you manage your own care at home?	Y/N	520	73.46	26.54
Q24	In the past 6 months, has any doctor given you instructions for one of your conditions that conflicted with what you have been told to do for another condition?	N/S/U/A*	622	67.04	10.77
Q25	In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?	A/U/S/N	570	60.35	5.26
Q26	In general, do you think the doctors you see communicate with each other about your care?	A/U/S/N	570	46.84	5.96
Q28	Did you leave the hospital with a readable and easily understood written list of the appointments or tests you needed to complete within the next several weeks?	Y/N	237	92.83	7.17
Q29	Did you leave the hospital confused about what medicine to take when you got home?	N/Y*	237	89.03	10.97
Q31	When you left the emergency room, did you receive a written list of what care you received?	Y/N	267	78.65	21.27
Q32	Did you leave the emergency room confused about exactly what medicine to take when you got home?	N/Y*	267	89.14	10.86
Q35	In the past 12 months, how often did you feel your time was wasted because your medical care was poorly organized?	A/U/S/N*	719	74.27	1.95

* Response coding was reversed such that good care coordination is the reference category.

Table 2-5. Claims-based care coordination measure properties and correlation among survey respondents

Measure	Mean (SD)	Tertile	N (%)	COC	SECON	UPC	HH	NOP	Site
Continuity of Care (COC)	0.26 (0.20)	High	234 (33.9)	1.00					
		Middle	244 (33.4)						
		Low	223 (34.6)						
Sequential Continuity (SECON)	0.32 (0.21)	High	248 (33.9)	0.71	1.00				
		Middle	220 (30.1)						
		Low	263 (36.0)						
Usual Provider of Care (UPC)	0.56 (0.22)	High	240 (32.8)	0.71	0.59	1.00			
		Middle	233 (31.9)						
		Low	258 (35.3)						
Herfindahl Index	0.29 (0.20)	High	250 (34.2)	0.98	0.68	0.70	1.00		
		Middle	256 (35.0)						
		Low	225 (30.8)						
Number of Providers	4.67 (2.77)	0 to 3	279 (38.2)	0.66	0.53	0.80	0.71	1.00	
		4 to 5	234 (32.0)						
		6 or more	218 (29.8)						
Site Index	0.46 (0.20)	High	240 (32.8)	0.59	0.48	0.52	0.63	0.44	1.00
		Middle	249 (34.1)						
		Low	242 (33.1)						

Table 2-6. Summary of care coordination dimensions and measures collected for the factor analysis

Care Coordination Dimension	Claims-based Measures	Survey Measures	Total Number of Measures
All Collected Measures			
Coordination by Specialists	COC Index, Sequential Continuity	Q17, Q18	4
Coordination by Usual Source of Care	UPC Index, Herfindahl Index	Q9, Q13, Q35	5
Information Continuity Between Clinicians	Number of Providers Seen, Site Index	Q6, Q24, Q25, Q26	6
Information Flow to Patients	NA	Q10, Q15, Q19, Q28, Q29, Q31, Q32	7
Longitudinal Continuity	NA	Q10	1
Total	6	17	23
After Exclusions			
Coordination by Specialists	COC Index, Sequential Continuity	NA	1
Coordination by Usual Source of Care	UPC Index	Q35	3
Information Continuity Between Clinicians	Number of Providers Seen, Site Index	Q6, Q24, Q25, Q26	6
Information Flow to Patients	NA	Q10, Q15, Q19	3
Longitudinal Continuity	NA	Q10	1
Total	5	9	14

NA: None Applicable, COC = Continuity of Care, UPC = Usual Provider Continuity. See Table 5 for survey questions.

Table 2-7. Rotated factor loadings and communality (N = 347) following factor analysis

	Factor 1	Factor 2	Factor 3	Domain Communality
COC Index	**0.80**	0.02	0.05	0.64
SECON	**0.66**	0.00	-0.01	0.44
UPC Index	**0.86**	0.01	-0.03	**0.74**
Number of Providers	**0.79**	-0.04	0.00	0.62
Site Index	**0.55**	0.09	(0.06)	0.30
Q24. In the past 6 months, has any doctor given you instructions for one of your conditions that conflicted with what you have been told to do for another condition?	0.11	**-0.42**	0.21	0.18
Q19 Did this specialist give you a written plan or instructions to help you manage your own care at home?	-0.01	**0.75**	0.01	0.56
Q15. Does your doctor give you a written plan or instructions to help you manage your own care at home?	0.04	**0.84**	0.15	**0.71**
Q34. In the past 12 months, how often did you feel your time was wasted because your medical care was poorly organized?	-0.00	-0.04	**0.54**	0.29
Q25. In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?	0.03	-0.02	**0.84**	**0.71**
Q14. In the last 6 months, when your doctor ordered a blood test, x-ray, or other test for you, how often did someone from your doctor's office follow up to give you those results?	0.02	0.17	**0.64**	0.41
Q26. In general, do you think the doctors you see communicate with each other about your care?	-0.08	0.07	**0.75**	0.56
Q6. Over the past 6 months, when receiving care for your diabetes, were you satisfied that your care was well organized	0.02	0.16	**0.49**	0.24
Q10. How long have you been going to your doctor?	0.04	0.04	0.08	

Note: Factor loadings >0.4 and the largest communality are in bold.
Abbreviations: COC = Continuity of Care, UPC = Usual Provide of Care, SECON = Sequential Continuity

Table 2-8. Internal scale reliability and inter-scale correlation

	Care Continuity (Factor 1)	Information Flow to the Patient (Factor 2)	Information continuity between clinicians (Factor 3)
Care continuity	(0.83)		
Information Flow to the Patient	0.01	(0.56)	
Information continuity between clinicians	0.06	0.31	(0.70)

Figure 2-1. Measure selection diagram

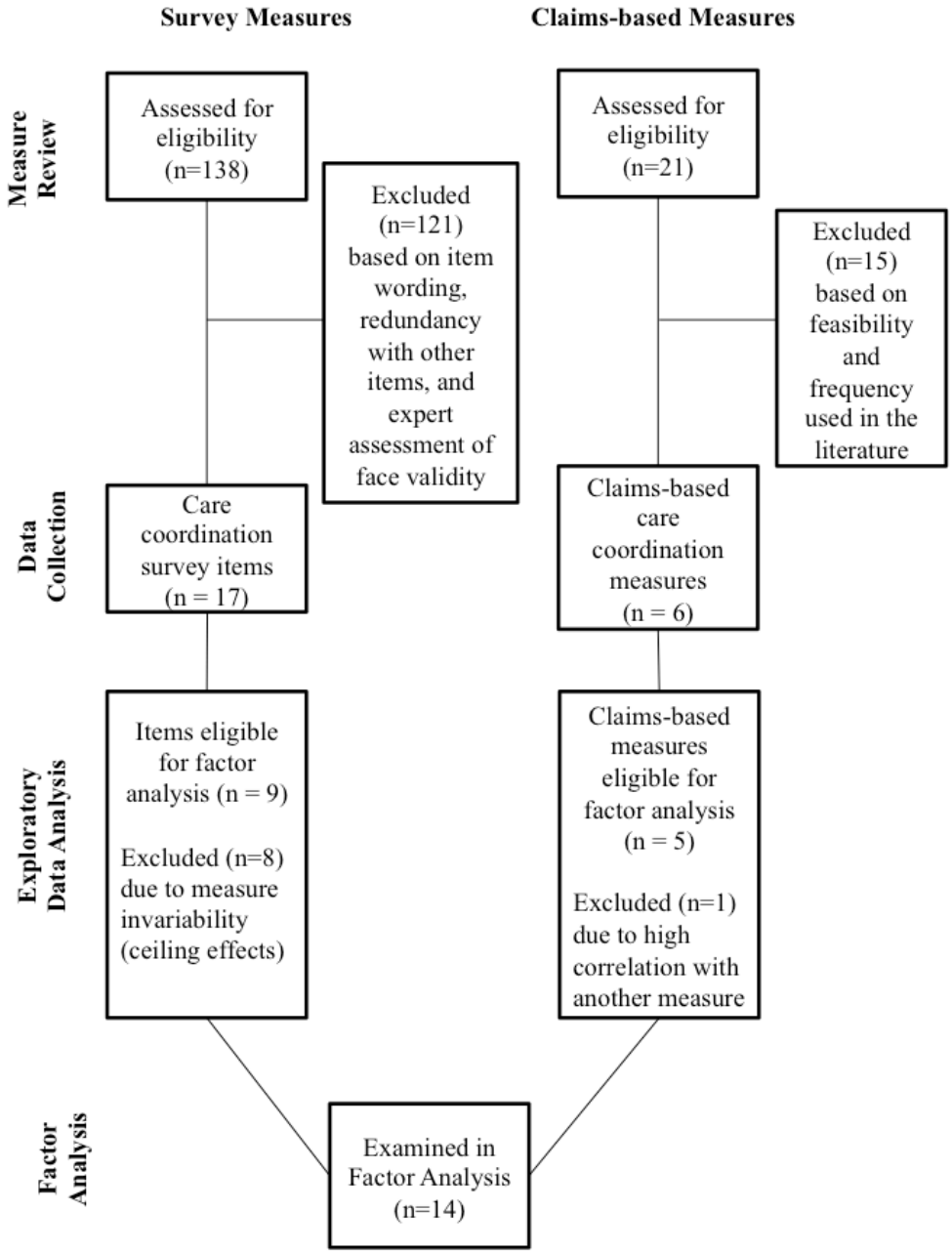
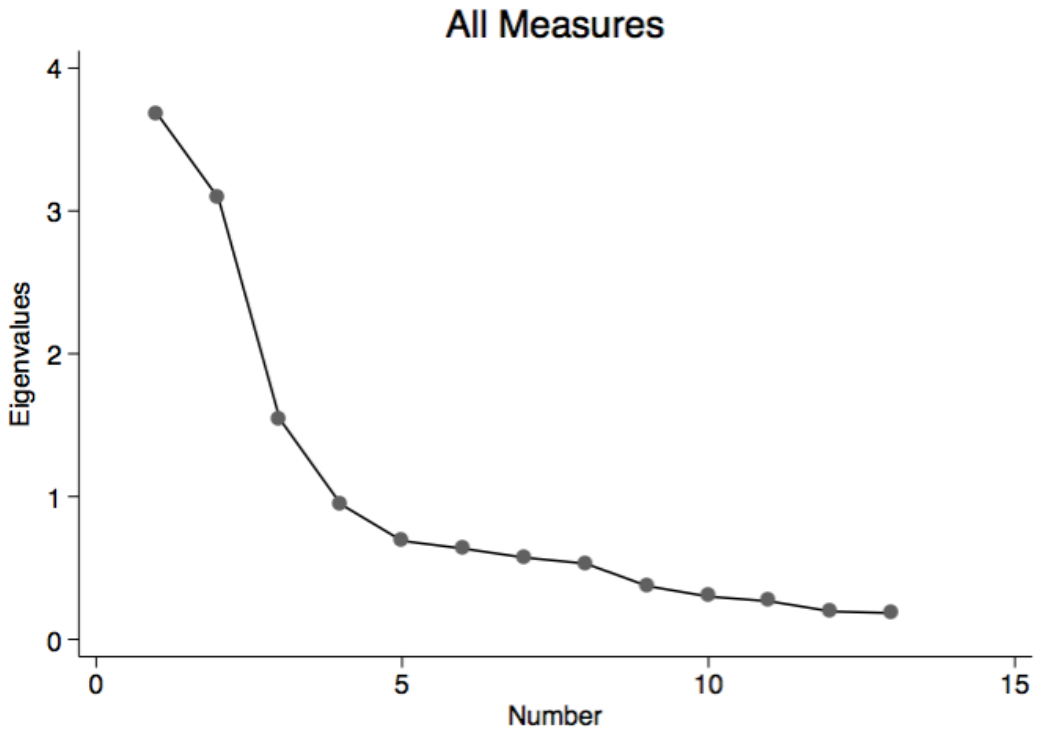


Figure 2-2. Scree plot of principle component analysis



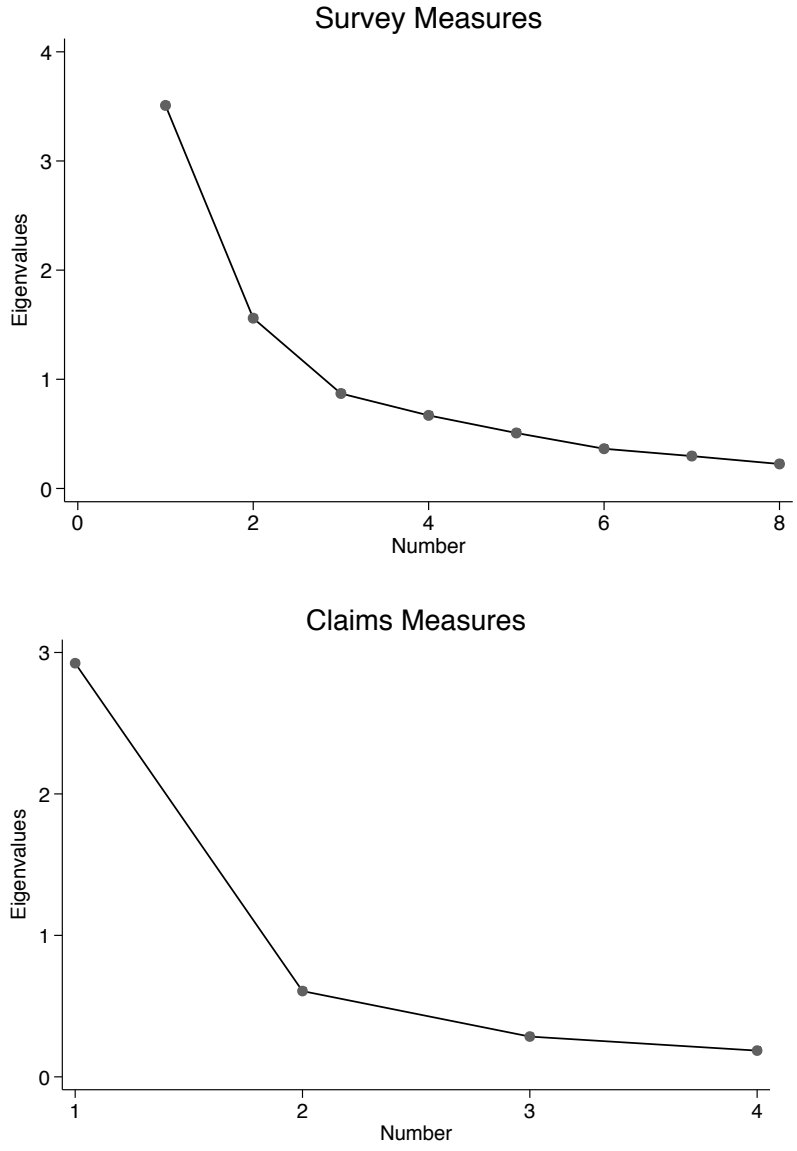
Appendix Table 2-1. Study sample and survey respondent characteristics

	Study Sample	Excluded Survey Subjects	N	P-value
Sample Size (N)	347	411	758	
Age (%)				0.172
65-69	24.78	21.9	176	
70-79	54.18	51.34	399	
>=80	21.04	26.76	183	
Race (%)				0.003
White	48.99	38.44	328	
Not White	51.01	61.56	430	
Gender (%)				0.039
Female	59.65	66.91	482	
Male	40.35	33.09	276	
Original Reason for Medicare Eligibility (%)				0.971
Age	72.62	72.51	550	
Disability	27.38	27.49	208	
ESRD				
Any Limitations in Activities of Daily Living (%)				0.685
None	79.25	77.86	595	
Yes	11.82	13.87	98	
Missing	8.93	8.27	65	
Language (%)				0.077
English	98.27	96.11	736	
Spanish	1.73	3.89	22	
Any Medicaid Enrollment (%)				0.035
None	48.99	41.36	44.85	
Yes	51.01	58.64	55.15	
Number of Chronic Conditions (%)				<0.001
<6	13.83	27.74	162	
6-10	36.89	40.63	295	
11+	49.28	31.63	301	
State (%)				0.136
Arkansas	7.78	7.3	57	
Georgia	31.41	33.09	245	
Missouri	7.49	3.89	42	
South Carolina	27.09	32.36	227	
Texas	26.22	23.36	187	

Appendix Table 2-2. Rotated factor loadings using all survey respondents (N=758)

	Factor 1	Factor 2	Factor 3	Comm-unality
COC Index	**0.83**	-0.08	0.09	0.69
SECON	**0.72**	-0.04	-0.03	0.52
UPC Index	**0.89**	0.09	-0.08	**0.79**
Number of Providers	**0.83**	0.00	-0.02	0.69
Site Index	**0.61**	0.01	-0.01	0.37
Q24. In the past 6 months, has any doctor given you instructions for one of your conditions that conflicted with what you have been told to do for another condition?	0.01	**-0.43**	0.21	0.18
Q19 Did this specialist give you a written plan or instructions to help you manage your own care at home?	-0.02	**0.87**	0.03	**0.76**
Q15. Does your doctor give you a written plan or instructions to help you manage your own care at home?	0.04	**0.57**	0.37	0.32
Q26. In the past 12 months, how often did you feel your time was wasted because your medical care was poorly organized?	0.03	0.02	**0.54**	0.29
Q25. In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?	-0.04	0.00	**0.74**	**0.55**
Q14. In the last 6 months, when your doctor ordered a blood test, x-ray, or other test for you, how often did someone from your doctor's office follow up to give you those results?	0.01	0.03	**0.74**	0.55
Q26. In general, do you think the doctors you see communicate with each other about your care?	-0.07	0.01	**0.74**	0.55
Q6. Over the past 6 months, when receiving care for your diabetes, were you satisfied that your care was well organized	0.06	0.15	**0.46**	0.21
Q10. How long have you been going to your doctor?	0.01	-0.09	0.14	

Appendix Figure 2-1. Scree plot of separate survey and claims data principal component analysis



Appendix Table 2-2. Care coordination survey measures and dimensions

Dimensions	Item	Question	Source
Informational Continuity Between Clinicians	Q6	Over the past 6 months, when receiving care for your diabetes, were you satisfied that your care was well organized?	Patient Assessment of Care for Chronic Conditions (Glasgow et al. 2005)
Coordination by USOC	Q9	Is there a doctor or place that you usually go if you are sick or need advice about your health?	Medicare Current Beneficiary Survey (Office of Research 2010c)
Longitudinal Continuity	Q10	How long have you been going to your doctor?	Medicare Current Beneficiary Survey (Office of Research 2010c)
Coordination by USOC	Q13	Do you think your doctor has a complete understanding of all the things that are wrong with you?	Medicare Current Beneficiary Survey (Office of Research 2010c)
Information Flow to the Patient	Q14	In the last 6 months, when your doctor ordered a blood test, x-ray, or other test for you, how often did someone from your doctor's office follow up to give you those results?	Patient's Perspective on Integrated Patient Care (Singer et al. 2012)
Information Flow to the Patient	Q15	Does your doctor give you a written plan or instructions to help you manage your own care at home?	Commonwealth Fund International Health Policy Survey (Schoen et al. 2008)
Coordination by Specialist	Q17	Do you think this specialist knew all the medications you were taking?	Patient's Perspective on Integrated Patient Care (Singer et al. 2012)
Coordination by Specialist	Q18	Do you think this specialist has a complete understanding of the things that are wrong with you?	Patient's Perspective on Integrated Patient Care (Singer et al. 2012)
Information Flow to the Patient	Q19	Did this specialist give you a written plan or instructions to help you manage your own care at home?	Commonwealth Fund International Health Policy Survey (Schoen et al. 2008)
Informational Continuity Between Clinicians	Q24	In the past 6 months, has any doctor given you instructions for one of your conditions that conflicted with what you have been told to do for another condition?	Commonwealth Fund International Health Policy Survey (Schoen et al. 2008)

Appendix Table 2-2. Care coordination survey measures and dimensions (Continued)

Dimension	Item	Question	Source
Informational Continuity Between Clinicians	Q25	In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?	Commonwealth Fund International Health Policy Survey (Schoen et al. 2008)
Informational Continuity Between Clinicians	Q26	In general, do you think the doctors you see communicate with each other about your care?	Patient's Perspective on Integrated Patient Care (Singer et al. 2012)
Information Flow to the Patient	Q28	Did you leave the hospital with a readable and easily understood written list of the appointments or tests you needed to complete within the next several weeks?	Care Transitions Measure (Coleman et al. 2002)
Information Flow to the Patient	Q29	Did you leave the hospital confused about what medicine to take when you got home?	Care Transitions Measure (Coleman et al. 2002)
Information Flow to the Patient	Q31	When you left the emergency room, did you receive a written list of what care you received?	Care Transitions Measure (Coleman et al. 2002)
Information Flow to the Patient	Q32	Did you leave the emergency room confused about exactly what medicine to take when you got home?	Care Transitions Measure (Coleman et al. 2002)
Coordination by USOC	Q35	In the past 12 months, how often did you feel your time was wasted because your medical care was poorly organized?	Commonwealth Fund International Health Policy Survey (Schoen et al. 2008)

Chapter 3: Care Coordination and Quality of Care in Older Adults with Multiple Chronic Conditions

3.1. Abstract

Background: Care coordination programs are complex interventions expected to improve quality of care. There is limited evidence on the relationship between different dimensions of care coordination and quality of care.

Objective: To examine the relationship between different dimensions of care coordination and quality of care in older adults with multiple chronic conditions.

Study Sample: 758 older adults with diabetes and other chronic conditions living in Arkansas, Georgia, Missouri, South Carolina, and Texas enrolled in a Medicare Advantage Chronic Care Special Needs Plan from July 1, 2010 to September 30, 2011.

Key Measures: Care coordination is measured three different ways. Patient survey questions are used to assess: 1) the patient's perception of whether their provider is informed and up-to-date and 2) whether the patient received a written plan of care or instructions from their usual source of care. Continuity of care is measured using the Usual Provider of Care Index. Quality of care process measures included appropriate diabetes care, the number of high-risk medications in the elderly, primary care follow up after a hospitalization, and patient rating of care.

Methods: Patient level experiences of care coordination were collected from a patient mail survey of older adults with multiple chronic conditions enrolled in a Medicare Advantage Plan. The survey oversampled patients with multiple chronic conditions. The patient survey data was linked with administrative claims data. Multivariable logistic regression was used to assess the association between three distinct care coordination dimensions and quality of care.

Results: We find that the relationship between care coordination and quality of care varies by type and level of care coordination. Among the 42 adjusted odds ratios estimating the association between care coordination and quality of care, 3 were statistically significant at $p \leq 0.05$ and 5 were significant at $p \leq 0.10$. We find a strong and increasingly positive relationship between survey measures of informational continuity between clinicians and informational continuity to the patient with higher patient rating of care. Patients with renal disease receiving the highest level of care informational continuity and continuity of care, were more likely to not be prescribed a contra-indicated medication.

Conclusions: We find that the relationship between care coordination and quality of care varies by care coordination domain. Medicare and health plans should consider taking steps to incentivize informational continuity between clinicians because it improves patient rating of care.

3.2. Introduction

In 2003, the Institute of Medicine (IOM) recommended care coordination as a priority area for quality improvement. Care coordination is considered to be a cross-cutting intervention that could improve the quality of preventive, acute, chronic, and palliative care (Anderson and Horvath 2004; Institute of Medicine 2003). Care coordination is thought to be particularly important to improving the quality of care processes and outcomes for older adults with multiple chronic conditions who account for more than 95 percent of Medicare spending (Anderson 2010), and are more likely to experience medication errors (Lu and Roughead 2011), breakdowns in provider communication (Burgers et al. 2010), and high-cost preventable events (Kim et al. 2010; Niefeld et al. 2003; Wolff, Starfield, and Anderson 2002).

Clinical quality is typically measured with respect to clinical practice guidelines (Brook et al. 1996). Assessing quality of care in people with multiple chronic conditions is challenging because few clinical practice guidelines define appropriate care for people with multiple co-morbidities (Boyd et al. 2005; Tinetti et al. 2004). In some cases, disease specific guidelines may conflict or suggest services that may provide little marginal benefit to complex patients (Tinetti et al. 2004). Previous studies assessing quality of care in older adults with multiple chronic conditions report that the likelihood of receiving good care increases with clinical complexity as measured by number of co-morbidities (Bae and Rosenthal 2008; Higashi et al. 2007; Min et al. 2007; Woodard et al. 2011). However, these studies continue to find that a substantial proportion of older adults do not receive care consistent with clinical practice guidelines.

In the past twenty years, Medicare and private insurers have invested in numerous care coordination programs (Nelson 2012). Several of these programs have assessed quality of care, but few have reported significant improvements in care quality or health care spending (Boyd et al. 2010; Nelson 2012; Peikes et al. 2009; Reid et al. 2009; Salmon et al. 2012). In general, previous evaluations find that care coordination programs do improve better patient experiences of care (Alexander and Bae 2012), and some reduce use of hospital services (Naylor et al. 2011). These analyses have two important limitations. One, care coordination interventions could involve a range of strategies from telephonic support to an in-office care coordinator using health system-wide electronic health record. Interventions may draw on different dimensions of care coordination, but often there is no distinction drawn in the intensity or comprehensiveness of the intervention. In addition, there is often no distinction in the location of the intervention. Both the Transitional Care program which focuses on improving hospital to community care transitions for high risk individuals as well as the patient-centered medical home, which is typically focused on primary care practices, are considered care coordination interventions even through they address different parts of the health care delivery system and patients with different types of health needs (Alexander and Bae 2012; Naylor et al. 2004). Disaggregating the multidimensional nature of care coordination interventions may be useful for policymakers and health care providers so that they can better identify what aspects of these interventions are most likely to result in better care and better outcomes.

Two, care coordination interventions are often deployed in a heterogeneous population combining individuals with one chronic condition and individuals with 10

chronic conditions and deficiencies in activities of daily living in the same group. Interventions that include relatively healthy participants who may not benefit from the intervention in the near term are less likely to identify meaningful changes in rare, adverse outcomes. For example, the Medicare Care Coordination Demonstration evaluation found that comprehensive care coordination interventions were more effective in high risk subgroups than in the broader, healthier treatment group (Brown et al. 2012).

While care coordination programs employ a broad range of strategies and activities (McDonald et al. 2007), there is little evidence examining different aspects of care coordination programs and their relationship to quality of care in older adults with multiple chronic conditions. Without a better understanding of what individual or combination of care coordination activities can improve care quality and patient experiences, care coordination interventions may fail to deliver better care and lower health care spending. A better understanding what aspects of care coordination improve (or worsen) quality indicators could improve the design of current and future interventions. Further study of the specific elements of care coordination programs is also important for guiding expectations about what care coordination programs can achieve in terms of improving quality of care, health outcomes, and reducing unnecessary health care spending.

In Chapter 2, we identified three distinct domains of care coordination: informational continuity between clinicians, information flow to the patient, and continuity of care. In this study, we examine the relationship between measures of these three domains are associated with quality of care in a sample of older adults with diabetes and other chronic conditions. We study this issue in older adults with diabetes because diabetes is a

common chronic condition affecting about 28% of the elderly in the Medicare program (Centers for Medicare and Medicaid Services 2012).

3.3. Methodology

3.3.1. Data Sources

We analyzed a de-identified dataset of linked patient survey and administrative data collected from July 2010 to September 2011 as part of a mail survey. Of 1,579 eligible survey subjects, 758 members of a Medicare Advantage Chronic Care Special Needs Plan responded to the survey (response rate = 48%).

The survey instrument, developed by the author, included 45 questions: 17 items relevant to the dimensions of care coordination, nine items about care quality and utilization, five items about diabetes self-care, five items about health status, and seven items about demographic characteristics.

Administrative claims and care management data were linked to the patient survey data were collected from the Medicare Advantage plan. Claims data included all final paid bills from July 2010 to September 2011. Claims data included a unique patient identifier, diagnosis codes, procedure codes, national provider identifier (NPI), tax identifier, physician specialist codes, and service dates. Care management data information collected from the health plan's annual house call program on activities of daily living and care management contacts.

3.3.2. Study Sample

The study sample included 758 diabetics selected from 24,000 individuals enrolled in Medicare Advantage Chronic Care Special Needs Plan. In order to be eligible

for the study, a health plan member had to be at least 65 as of January 1, 2010, alive during the study period, continuously enrolled during the study period, and enrolled in a plan in Arkansas, Georgia, Missouri, South Carolina, or Texas.

3.3.3. Care Coordination Measures

We assess three different dimensions of care coordination identified in Chapter 2: informational continuity between clinicians, informational continuity to the patient, and care continuity. A single item with the largest community was selected from each dimension as most representative based on exploratory polychoric factor analysis.

Informational continuity between providers measures how well providers share information about the patient's care. This dimension is captured by the patient survey question: "In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?" The response scale for this measure is a four-point likert scale (always, usually, sometimes, never).

Informational continuity to patient measures whether clinicians provide care plans and clear instructions to patients. This dimension is captured by the question "Does your doctor give you a written plan or instructions to help you manage your own care at home?" The response scale for this measure is a four-point likert scale (always, usually, sometimes, never).

Continuity of care examines how a patient's care is distributed between providers. Care that is more fragmented is thought to represent poor care coordination. This dimensions is assessed by the Usual Provider of Care (UPC) Index, which quantifies the proportion of visits with one's primary care provider with respect to all other clinicians (Breslau and Reeb 1975). In the literature, a meaningful unit of change in the UPC Index

is often categorized by a change in tertile based on the patient distribution. In this study, we categorize the UPC Index by tertile in the survey-weighted sample.

As a sensitivity test we also examine care coordination using the dimension score from each domain. The scale score was constructed as the sum of each item in the domain standardized to have a mean of 0 and standard deviation of 1.

3.3.4. Outcome Measures

Medicare Advantage Special Needs Plans are required by Medicare to report on 13 Healthcare Effectiveness Data and Information Set (HEDIS) performance measures (National Committee for Quality Assurance 2013). These measures assess a wide range of clinical areas including medication management, care transitions, and patient experience of care. Of these 13 measures, we were able to construct five measures: inappropriate use of medications in individuals with chronic renal disease, use of one or more high risk medications in the elderly, use of two or more high risk medications in the elderly, post hospitalization follow up with a primary care physician within 14 days of discharge, and post hospitalization follow up with a primary care physician within 30 days of discharge. Where there are two thresholds for the same care, such as one or more high risk medications and two or more high risk medications, we focus on the more stringent measure: one or more high risk medications and post hospitalization follow up with a primary care physician within 14 days of discharge.

We did not collect the HEDIS measure for patient rating of care, which is: "Using any number from 0 to 10, where 0 is the worst health care possible and 10 is the best health care possible, what number would you use to rate all your health care in the last 12 months?" For this item, we use a similar question collected from the patient survey:

"Overall, how do you rate the quality of medical care that you have received in the past 12 months?" The response scale was a five point likert scale (excellent, very good, good, fair, poor). Responses were sorted into two categories: excellent and very good compared to good, fair, and poor.

The remaining seven HEDIS measures (inappropriate medications in people with dementia, inappropriate medications in people with a high falls risk, use of a beta blocker after a myocardial infarction, two appropriate medication use measures for people with chronic obstructive pulmonary disease, primary care follow up after a mental health hospitalization, emergency department use in people experiencing a stroke, and appropriate depression medication use) could not be used in this study because there were insufficient observations for analyses.

Because our focus is on patients with diabetes and other chronic conditions, we supplemented the list of HEDIS measures with quality measures commonly used to assess diabetes care: receipt of an eye exam during the study period, receipt of at least one glycated hemoglobin test, and receipt of at least one low-density lipoprotein cholesterol test (Dugoff et al. 2013; National Committee for Quality Assurance 2013).

Appendix Table 3-1 summarizes the measures used in this study. Measures were constructed using final paid claim. Medication use measures were constructed using billed national drug codes (NDC). NDC codes were categorized into relevant categories (e.g., statins, beta blockers) according publically available crosswalks provided by NCQA (NCQA 2013). Preventive care for diabetes was constructed using billed procedure codes and physician specialty codes as appropriate. Receipt of a post-hospital or emergency room physician visit was defined as having either a community-based

office physician visit or a post-hospital discharge home visit from a Medicare Advantage plan clinician or a post-hospital discharge telephone call visit from a Medicare Advantage plan clinician.

3.4. Analytic Approach

All analyses were conducted in Stata version 12 (StataCorp 2011). For all descriptive analyses, we tested for differences by care coordination using chi-square tests for categorical measures. All results were adjusted using survey weights accounting for survey design, probability of selection, and survey subject non-response. Relationships where $p \leq 0.05$, that is where the probability that any observed difference between groups is due to chance is greater than 95%, are typically considered statistically significant. We focus on relationships were $p \leq 0.05$, but also consider relationships a lower statistical significance cutoff, $p \leq 0.1$, to be potentially meaningful.

We examine the relationship between each quality measure and patient characteristics using bivariate analyses. We use multivariate logistic regression models accounting for the survey design to examine the association between quality of care and each measure of care coordination using the Wald test. Because each care coordination item compares high to low and middle to low using separate indicators, we also examine the joint significance of both indicators using the Wald test. Multivariate analyses control for individual level characteristics considered to be related to health care service use according to the Aday-Andersen Health Behavior Model (Aday and Andersen 1974). Predisposing factors were measured by age (65 to 69, 70 to 79, and 80 and older) and race (White or not White). Enabling factors include characteristics thought to support access to health care services were measured by self-reported education (12 years of

education or more, less than 12 years of education, and no response), income (<$10,000, >$10,000, and no response), marital status (married, not married, and no response). Health needs are factors affecting demand for health care services. These include number of chronic conditions as measured using the Clinical Classification Software and Chronic Condition Indicator (Agency for Healthcare Quality and Research 2012; Hwang et al. 2001) and number of evaluation and management visits (0-13, 14-23,24-38, 39+) during the study period. All models also controlled the subject's state of residence, which controls for unobserved differences occurring at the state level.

We conducted a number of planned sensitivity analyses to assess the robustness of our results. We examined whether our results were sensitive to the specification of key variables. We examined models where number of chronic conditions were measures as a continuous variable as well as models testing self-reported care coordination measures in their original 4-level likert scale. We also examined the relationship between care coordination measures and alternative specification of quality measures: lower threshold quality measures, such as two or more high-risk medications in the elderly, and care coordination measures. Lastly, we examined the relationship between care coordination domain scores and quality measures.

3.5. Results

3.5.1. Patient Characteristics

Survey respondents and non-respondents were similar on most patient-level characteristics available in administrative claims (Table 1). A larger proportion of non-respondents had one or more difficulties with an ADL (15.6% of non-respondents compared to 12.9% of respondents) and nearly twice as many non-respondents did not

have a record of an ADL assessment (17.9% compared to 8.6%). Non-respondents had fewer physician visits compared to respondents.

After adjusting for survey non-response and probability of being selected, 59% of plan members reported "Always" to the question "In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians"; 19% reported "Never" or "Sometimes" and 22% reported "Usually". Forty-nine percent of respondents reported "always" to the question "Does your doctor give you a written plan of instructions to help you manage your own care at home"; 33% reported "Never" or "Sometimes" and 19% reported "Usually. Thirty-two percent of the sample had care patterns in the lowest tertile of the Usual Provider of Care (UPC) Index, 36% in the middle tertile, and 33% in the highest tertile.

Table 3-2 presents the distribution of patient characteristics by quality of care. There were some differences between patients receiving concordant care compared to those receiving discordant care. Younger respondents were more likely to report receiving excellent or very good care (80% of respondents ages 65 to 69 reported excellent or very good care compared to 75% of respondents 70 to 79 and 64% of respondents 80 and older; p-value<0.05). White respondents were more likely to not be taking one or more prescription medication considered high risk in the elderly (66% of white respondents compared to 54% of non-white respondents, p<0.05) and more likely to report receiving excellent or very good care (82% compared to 68%, p<0.05).

3.5.2. Multivariate Analysis

The association of care coordination and quality of care varied by care coordination dimension. In multivariate analyses, patients reporting greater informational

continuity between clinicians and informational continuity to patients were more likely to report receiving very good or excellent care. Patients reporting their doctor was usually informed and up-to-date were 2.7 times more likely to report receiving very good or excellent care and patients reporting their doctor was always informed and up-to-date were 8 times more likely to report receiving very good or excellent care. Patients reporting that their doctor always gave them a written plan or instructions were 5.7 times more likely to report receiving very good or excellent care. Greater information flow to the patient was also associated with 3.3 times greater odds of receiving appropriate medication in patients with chronic renal disease. Diabetes care quality measures were not statistically significantly related to care coordination dimensions. Table 3 presents the adjusted odds ratios and p-values for each care coordination dimension and quality of care measure as well as the p-values of the Wald test assessing the joint significance of the care coordination measures. Figure 1 presents the adjusted odds ratios and 95% confidence intervals for each care coordination dimension and quality of care measure.

After adjusting for patient-level characteristics, patients reporting their doctors were "always" informed and up-to-date about their care with specialists were 8 times (OR: 8.1, $p<0.01$) more likely to report they received "excellent" or "very good" care in the last 12 months compared to patients reporting "never" or "sometimes" (Table 3 and Figure 1). Patients reporting their doctors were "usually" informed and up-to-date were 2.7 times more likely to report "excellent" or "very good" care (OR: 2.7, $p=0.01$). Patients reporting their doctor was "always" provided a written plan or instructions were nearly six times more likely to report "excellent" or "very good" care (OR: 5.7, $p<0.01$). Patients reporting their doctor "usually" provided a written plan or instructions were 1.7

times more likely to report “excellent” or “very good” care (OR: 1.8, p=0.09). Care coordination as measured by the UPC Index was not related to better patient rating of care.

The quality measure examining medication management for patients with chronic renal disease was associated with information flow to the patient. Patients reporting their doctor “always” provided written plan or instructions were more than three times more likely to receive care appropriate for renal disease (OR: 3.4, p=0.05). The joint significance test suggests that informational continuity between clinicians and continuity of care is statistically significantly associated with better care for patients with chronic renal disease at $p \leq 0.10$. Chronic renal disease patients in the highest tertile of the UPC Index were 4 times more likely to receive appropriate medications (OR: 4.0, p=0.10).

In sensitivity analyses, we examined the robustness of these results to model specification. Overall, the results were qualitatively similar when care coordination survey respondents reporting “always”, “usually”, and “sometimes” were compared separately to patients responding “never” (Appendix Table 3-1). In models where the chronic conditions variable grouped individuals with 1 to 10 and 11 or more conditions, results were qualitatively similar (Appendix Table 3-2). In analyses examining the relationship of domain scores and quality of care, the results were similar to the main analysis with one exception. Patients reporting better care coordination were statistically significantly less likely to have an eye exam during the study period (Appendix Table 3-3). Results were also consistent when we tested less restrictive specifications of hospital discharge and high-risk medication use in the elderly (Appendix Table 3-4). When we examine physician follow up within 30-days of discharge from the hospital and use or

two or more high risk medications in the elderly, we did not find that these domains were associated with better quality of care.

3.6. Discussion

Many care coordination evaluations have found little to no meaningful relationship between the care coordination and quality of care measures (Alexander and Bae 2012; Friedberg et al. 2014; Peikes et al. 2009; Reid et al. 2009). Previous studies have generally examined the overall effect of the intervention on quality of care measures, which may not identify the specific attributes of care coordination and key subpopulations where care coordination may be most effective (Brown et al. 2012). In contrast, in this study we take a more granular approach examining the relationship of different care coordination dimensions on multiple quality of care measures in older adults with multiple chronic conditions who are one group thought most likely to benefit from care coordination.

We find that the relationship between care coordination dimensions and quality of care varies. Among the 42 adjusted odds ratios estimating the association between care coordination and quality of care, only three were statistically significant at $p \leq 0.05$ and an additional five were significant at $p \leq 0.10$ in the main analysis. We find a strong and increasingly positive relationship between survey measures of informational continuity between clinicians and informational continuity to the patient with higher patient rating of care. Patients reporting receiving the highest level of information flow to the patient were more likely to receive appropriate medications for patients with chronic renal disease.

These findings are consistent with previous studies that have found that care coordination interventions are associated with better patient rating of care (Alexander and Bae 2012). Patient rating of care, which is one aspect of patient satisfaction, is considered an important and distinct dimension from technical quality of care (Chang et al. 2006; Manary et al. 2013; Sofaer and Firminger 2005). Manary and colleagues argue that researchers should address "how to improve patient experiences by focusing on activities (such as care coordination and patient engagement) found to be associated with both satisfaction and outcomes…" (Manary et al. 2013). This study, in part, addresses this gap finding that patients reporting their doctor to be always informed and up-to-date about their care and patients who usually or always receive a written plan or instructions rate their care higher.

We were surprised to find that three care coordination dimensions were not statistically significantly related to better transitions from hospital to home. Previous studies have found that robust hospital discharge transition interventions are associated with better health outcomes (Coleman, Mahoney, and Parry 2005). One reason we may not have found a stronger correlation between care coordination dimensions and primary care follow-up care after discharge may be that the care coordination measures did not directly measure the hospital discharge process. Further research should consider whether hospital discharge processes represent a separate domain of care coordination. Based on this study, patients with lower levels of continuity of care may benefit from additional supportive services including a follow up home visit or accompaniment to the clinician (Naylor et al. 2004).

This study presents new information for policymakers and health insurers on what types of care coordination are most likely to improve patient rating of care and clinical quality for older adults with multiple chronic conditions. In 2012, Medicare initiated the Quality Bonus Program which rewards Medicare Advantage plans based upon a quality score, called the 5-star rating system (Jacobson et al. 2011). In 2014, the 5-star rating system included 36 different measure of plan performance and clinical quality of which only one measure assessed care coordination. The care coordination measure is a six-item scale based on the Consumer Assessment of Healthcare Providers and Systems (CAHPS). In order to incentivize plans to emphasize comprehensive care coordination, Medicare could increase the number of measures assessing care coordination quality. Furthermore, the Medicare program should consider including items from different dimensions of care coordination because to promote improvement on multiple aspects of care quality. For example, the 5-star care coordination measure does not address whether the clinician offered the patient written plan or instructions to manage his or her care at home. This is one dimension of care coordination that is related to better patient rating of care and medication management in patients with chronic renal disease.

In 2013, the Centers for Medicare and Medicaid Services created three procedure codes to promote care transitions from the hospital as part of its effort to promote care coordination in the Medicare program (Centers for Medicare & Medicaid Services 2012). The 2012 CMS proposed rule on the physician fee schedule notes that currently some care coordination services are considered already covered under the fee schedule: specifically, evaluation and management codes for an outpatient office visit include "Revise treatment plan(s) and communicate with patient, as necessary" (Centers for

Medicare & Medicaid Services 2011). While Medicare currently covers physician communication with the patient about their treatment, the payment does not specifically address the provision of a written plan or instructions. Creating a new procedure code to cover provision of a care plan to medically complex patients would be one step that could improve patient rating of care as well as clinical quality.

Health plans can directly incentivize better care coordination by promoting informational continuity between clinicians in two ways. One possibility is for managed care plans to provide a patient's usual source of care with information on a patient's medical care utilization with other physicians. It is important to note that this approach may not be an efficient if the medical billing process is slow. An alternative approach would be for health plans to require a patient's usual source of care to keep up-to-date with their patient's care with other clinicians. Health plans could also reimburse providers for offering a written plan or instructions to patients since this dimension of care coordination is associated with better patient rating of care and better medication management in patients with chronic renal disease.

These findings should be considered in the context of the study's limitations. One, this study uses administrative data to assess quality of care, which only captures procedures and visits paid by the health insurer. This study did not have access to new CPT codes which indicate adherence to a target, such as cholesterol levels below 100 or glycated hemoglobin levels above 7. Two, this study relies on the patient reported experience of care coordination to assess information continuity between clinicians, which reflects the patient's impression, but not the physicians. However there are a number of scenarios where it can be expected where a patient would have actual

knowledge of informational continuity such as when it is mentioned by a physician or a physician calls another in the exam room. Three, patient self-report measures may be subject to recall bias. However to the extent that the care of older adults with multiple chronic conditions is provided by multiple clinicians and sites of care that are not connected by a unified patient record, the patient, as the common denominator, is the only source of information. This study was powered to detect a 15% difference in quality of care measures, and is underpowered to detect smaller changes.

It is important to note that this study does not address whether these quality indicators are an appropriate measure of good care for patients with multiple chronic conditions. In the case of patients with multiple conditions, a clinician may prioritize and re-prioritize a patient's care over time to meet the patient's changing health needs (Boyd et al. 2005). In addition some preventive care is not recommended, or may be deemed unnecessary, in older adults with limited life expectancy (Lee, Leipzig, and Walter 2013; Yourman et al. 2012). Lastly, this is a cross-sectional study which cannot determine the direction of the relationship between care coordination and quality of care.

3.7. Conclusion

Care coordination is generally regarded to be an important tool to improve the quality of care in the Medicare program. In this population, Medicare Advantage beneficiaries with multiple chronic conditions enrolled in a Special Needs Plan, we find some evidence that care coordination is associated with better patient rating of care and medication management. Medicare and health plans should consider taking steps to incentivize care coordination activities that result in better patient experiences of care and care quality.

Table 3-1. Characteristics of Study Sample in Study Sample by Survey Response

	Study Sample (%)			Survey Weighted (%)
	Response	Non-Response	Total	Total
	N = 758	N = 821	N = 1,579	N = 24,021
Age				
<70	23.2	20.7	21.9	25.2
70-79	52.6	53.8	53.3	51.7
80+	24.1	25.5	24.8	23
Race				
White	43.3	42	42.6	41.7
Not White	56.7	58	57.4	58.3
Gender				
Female	63.6	65.7	64.7	63.6
Male	36.4	34.3	35.3	36.4
Any Medicaid				
No	44.9	43.1	44	46.8
Any	55.1	56.9	56	53.2
ADLs				
None	78.5	66.5*	72.3	73
≥1 Problem	12.9	15.6	14.3	11.2
Missing	8.6	17.9	13.4	15.8
Chronic Conditions				
1-7	58.8	60.5	59.6	59.4
8-13	27.4	28	27.7	28.5
14+	13.8	11.5	12.7	12.1
Physician Visits				
0-7	32.8	28.4	30.7	46.4
8-13	23.8	21.6	22.7	24.2
14-19	21.7	22.6	22.1	16.2
20+	21.8	27.4	24.5	13.1
Any ER Use				
None	36.9	33.1	35	51.7
≥1 Admission	63.1	66.9	65	48.3

Note: ADL = Activities of Daily Living, ER = Emergency Room

* Significant difference of the patient characteristic by survey response based on a chi-square test ($p<0.05$)

Table 3-2. Target Population Characteristics By Quality of Care (Row Percent)

	≥1 Eye Exam		≥1 Hemoglobin A1c Test		≥1 Cholesterol Test		Renal Disease Drug Interaction		≥1 High Risk Medications		Primary Care 14 days After Hospital Discharge		Patient Rating of Care	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Good/ Fair/Poor	Excellent/ Very Good
N	413		413		413		231		758		385		734	
	36.6	63.4	7	93	12	88	22.6	77.4	41.0	59.0	56.4	43.6	26.6	73.4
Age														
<70	38.1	61.9	6.4	93.6	9.3	90.7	23.9	76.1	37	63	61	39	20.5	79.5*
70-79	35.3	64.7	7.5	92.5	14.1	85.9	22.2	77.8	42.6	57.4	53.3	46.7	25.2	74.8
80+	NA	NA					22.4	77.6	41.9	58.1	57.8	42.2	36.1	63.9
Race														
White	40.9	59.1	5.4	94.6	12.5	87.5	19.7	80.3	34.2	65.8*	58.6	41.4	18.2	81.8*
Not White	33.4	66.6	8.1	91.9	11.5	88.5	24.3	75.7	46	54	54	46	32.5	67.5
Gender														
Female	36.6	63.4	3.6	96.4	10.3	89.7	24	76	40.6	59.4	56.3	43.7	27.1	72.9
Male	36.6	63.4	12.1	87.9	14.4	85.6	20.6	79.4	41.7	58.3	56.3	43.7	25.7	74.3
Income														
<$10,000	37.3	62.7	8.1	91.9	9.1	90.9	19.5	80.5	39.8	60.2	56.5	43.5	25.2	74.8
>$10,000	35.7	64.3	6.9	93.1	15.9	84.1	19.8	80.2	44.8	55.2	56.4	43.6	28.6	71.4
Missing	36.3	63.7	2.8	97.2	10.9	89.1	46	54	32.3	67.7	55.5	44.5	24.5	75.5
Education														
>12 years	40.9	59.1	5.8	94.2	10.8	89.2	32.9	67.1*	33.1	66.9*	64.7	35.3*	22.5	77.5
≤12 years	33.7	66.3	8.6	91.4	11.9	88.1	18.2	81.8	45.4	54.6	52.6	47.4	30.7	69.3
Missing	27.4	72.6	2.3	97.7	22	78	5.5	94.5	55	45	30.3	69.7	14.2	85.8
ADLs														

Table 3-2. Target Population Characteristics By Quality of Care (Continued)

	≥1 Eye Exam		≥1 Hemoglobin A1c Test		≥1 Cholesterol Test		Renal Disease Drug Interaction		≥1 High Risk Medications		Primary Care 14 days After Hospital Discharge		Patient Rating of Care	
	No	Yes	No	Yes	No	Yes	No		No	Yes	No	Yes	Good/ Fair/Poor	Excellent/ Very Good
None	34.9	65.1	7.1	92.9	11.4	88.6	28.9	71.1	40.8	59.2	49.5	50.5	24.7	75.3
≥1 Problem	50.2	49.8	0.8	99.2	21.2	78.8	7.7	92.3	45.2	54.8	67.9	32.1	30.1	69.9
Missing	36.4	63.6	10.3	89.7	9.1	90.9	13.6	86.4	39.5	60.5	69.7	30.3	32.9	67.1
Chronic Conditions														
1-7	39	61	8.8	91.2	11.7	88.3	22.6	77.4	36.4	63.6*	57.9	42.1	25.2	74.8
8-13	30.5	69.5	4.2	95.8	13.4	86.6	29.1	70.9	49.3	50.7	53.7	46.3	32.1	67.9
14+	35.2	64.8	2.1	97.9	10.3	89.7	16.8	83.2	45.3	54.7	59.2	40.8	20.5	79.5
Physician Visits														
0-7	40.2	59.8	10.7	89.3*	14.3	85.7	15.5	84.5	32.4	67.6*	82.9	17.1*	27.5	72.5
8-13	33.8	66.2	2.6	97.4	6.6	93.4	27.6	72.4	43.5	56.5	38.5	61.5	29	71
14-19	39.8	60.2	8.4	91.6	17.3	82.7	15.8	84.2	47.4	52.6	50.4	49.6	24.8	75.2
20+	25.5	74.5	1	99	7.1	92.9	31.7	68.3	57.4	42.6	42.6	57.4	21	79

Note: ADL = Activities of Daily Living

* Significant difference of the patient characteristic by experience of care coordination based on a chi-square test ($p<0.05$)

Table 3-3. Adjusted Odds of Quality of Care by Level of Care Coordination

	≥1 Eye Exam	≥1 Hemoglobin A1c Test	≥1 Cholesterol Test	Renal Disease Drug Interaction	≥1 High Risk Medications	Primary Care After Hospital Discharge	Patient Rating of Care
	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)
"In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?"							
Never/Sometimes (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Usually	1.24 (0.69)	0.66 (0.68)	1.15 (0.87)	1.15 (0.89)	1.19 (0.64)	0.78 (0.70)	2.70 (0.01)
Always	0.55 (0.16)	0.47 (0.47)	0.46 (0.32)	0.31 (0.12)	1.55 (0.16)	0.58 (0.31)	8.07 (0.00)
Wald Test (P-value)	0.114	0.708	0.433	0.091	0.355	0.114	<0.001
"Does your doctor give you a written plan or instructions to help you manage your own care at home?"							
Never/Sometimes (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Usually	0.77 (0.54)	0.75 (0.70)	3.16 (0.16)	0.39 (0.13)	1.05 (0.87)	0.98 (0.97)	1.76 (0.09)
Always	0.70 (0.31)	2.04 (0.30)	1.43 (0.42)	3.35 (0.05)	1.04 (0.87)	1.12 (0.77)	5.66 (0.00)
Wald Test (P-value)	0.679	0.281	0.918	0.017	0.998	0.864	<0.001
Usual Provider of Care Index							
Low (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Middle	0.65 (0.21)	0.75 (0.73)	1.22 (0.74)	0.79 (0.71)	0.80 (0.40)	1.31 (0.53)	0.71 (0.24)
High	0.78 (0.57)	0.63 (0.63)	0.96 (0.96)	4.01 (0.10)	0.72 (0.23)	1.41 (0.44)	0.84 (0.58)
Wald Test (P-value)	0.517	0.784	0.896	0.077	0.469	0.083	0.339

Note. Odds ratios adjusted for age (65 to 70, 70 to 79, and ≥80), race (white vs not white), number of chronic conditions (>7,8-13,14+), number of visits (0-7,8-13,14-19, 20+), gender, deficiencies in activities of daily living (none, any, missing), marital status (married vs not married), education (high school graduate, ≤12 years, missing), income (<$10,000, >$10,000, missing) and state of residence (Arkansas, Georgia, Missouri, South Carolina, and Texas).

Figure 3-1. Adjusted Odds and 95% Confidence Intervals of Quality of Care by Level of Care Coordination

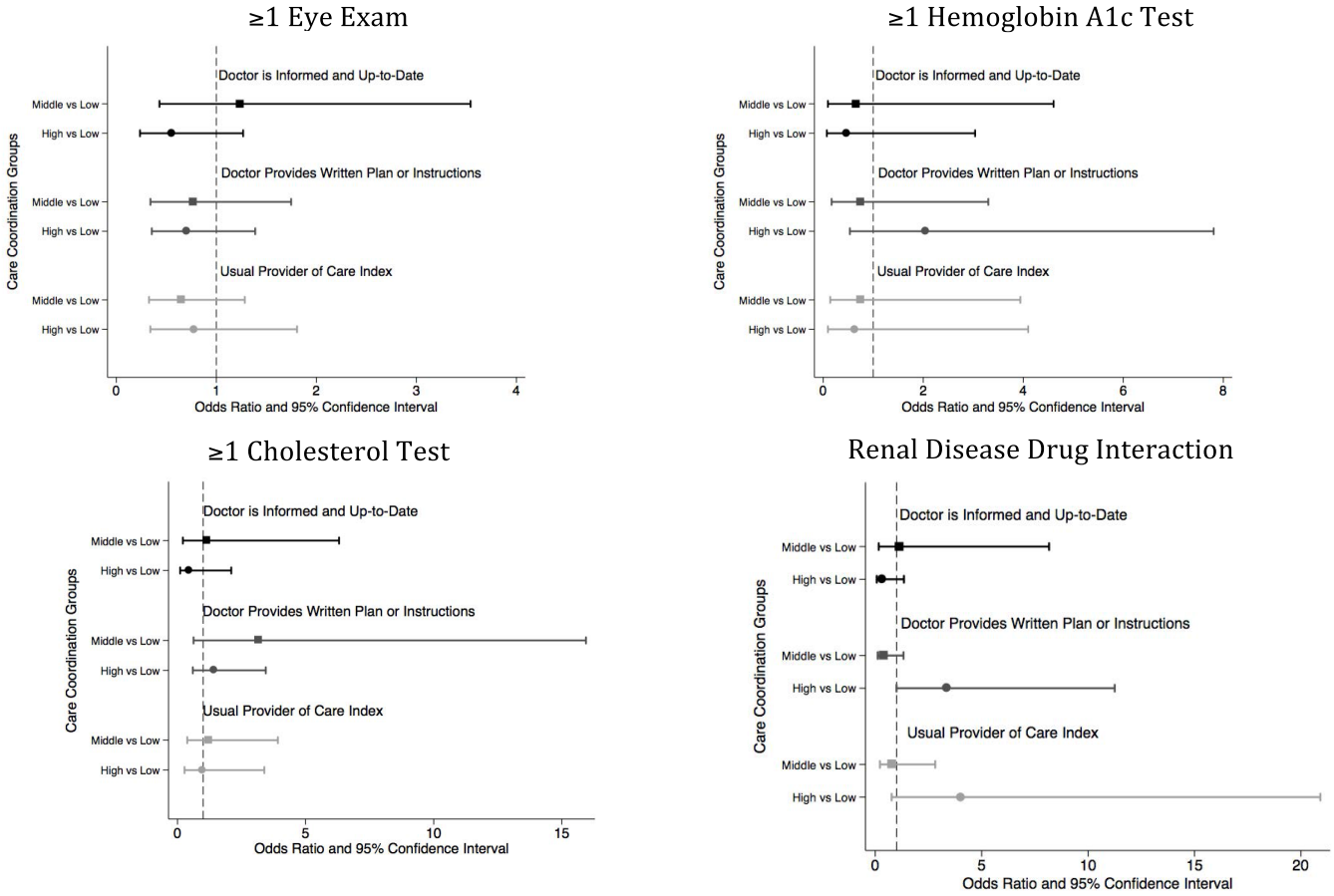
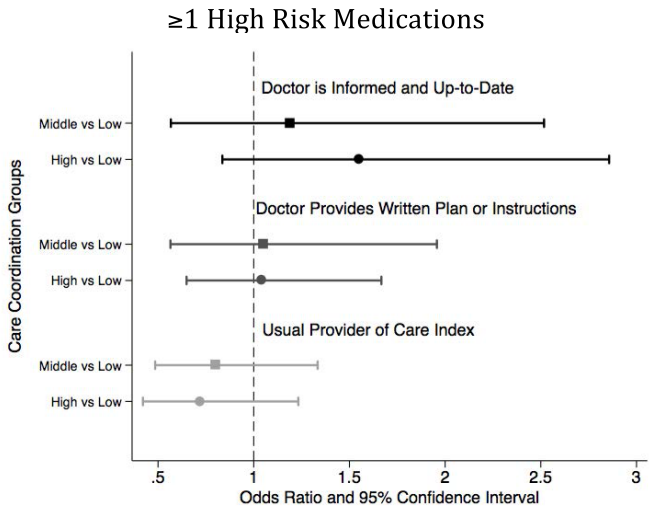
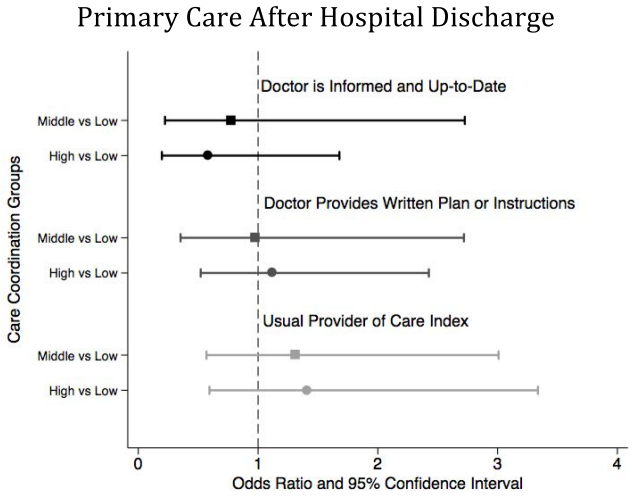
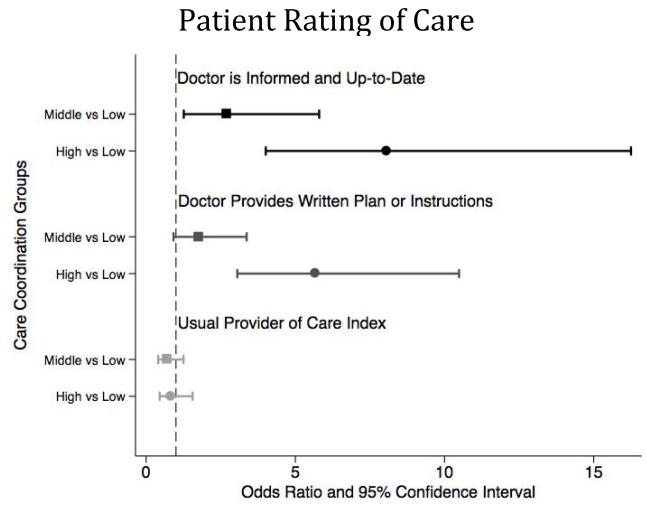


Figure 3-1. Adjusted Odds and 95% Confidence Intervals of Quality of Care by Level of Care Coordination (Continued)







Note: Doctor is Informed and Up-to-Date = “In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?”; Doctor Providers Written Plan or Instructions = “Does your doctor give you a written plan or instructions to help you manage your own care at home?”
For survey questions: low = “never” or “sometimes”, middle = “usually”, high = “always”. For the Usual Provider of Care Index: low = low tertile, middle, = middle tertile, high = highest tertile.

Appendix Table 3-1. Sensitivity Test Examining Specification of Care Coordination Measures

	≥1 Eye Exam	≥1 Hemoglobin A1c Test	≥1 Cholesterol Test	Renal Disease Drug Interaction	≥1 High Risk Medications	Primary Care After Hospital Discharge	Patient Rating of Care
	Odds Ratio (Pvalue)	Odds Ratio (Pvalue)	Odds Ratio (Pvalue)	Odds Ratio (Pvalue)	Odds Ratio (Pvalue)	Odds Ratio (Pvalue)	Odds Ratio (Pvalue)
"In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?"							
Never (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sometimes	0.82 (0.80)	0.90 (0.93)	2.45 (0..57)	11.12 (0.02)	1.55 (0.43)	0.30 (0.24)	0.53 (0.25)
Usually	1.09 (0.91)	1.43 (0.56)	1.72 (0.53)	4.93 (0.17)	1.57 (0.38)	0.35 (0.27)	1.84 (0.25)
Always	0.48 (0.36)	Ref	0.70 (0.64)	1.39 (0.73)	2.04 (0.13)	0.25 (0.13)	5.49 (0.00)
"Does your doctor give you a written plan or instructions to help you manage your own care at home?"							
Never (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sometimes	0.94 (0.91)	0.30 (0.25)	0.67 (0.63)	7.34 (0.02)	0.86 (0.68)	0.39 (0.16)	2.44 (0.03)
Usually	0.74 (0.56)	0.37 (0.33)	2.53 (0.32)	Omitted	0.97 (0.93)	0.56 (0.37)	2.88 (0.01)
Always	0.67 (0.39)	0.95 (0.96)	1.11 (0.88)	8.54 (0.00)	0.96 (0.89)	0.64 (0.44)	9.35 (0.00)

Note. Odds ratios adjusted for age (65 to 70, 70 to 79, and ≥80), race (white vs not white), number of chronic conditions(>7,8-13,14+), number of visits (0-7,8-13,14-19, 20+), gender, deficiencies in activities of daily living (none, any, missing), marital status (married vs not married), education (high school graduate, ≤12 years, missing), income (<$10,000, >$10,000, missing) and state of residence (Arkansas, Georgia, Missouri, South Carolina, and Texas).

Appendix Table 3-2. Sensitivity Test Examining Specification of Number of Chronic Conditions

	≥1 Eye Exam	≥1 Hemoglobin A1c Test	≥1 Cholesterol Test	Renal Disease Drug Interaction	≥1 High Risk Medications	Primary Care After Hospital Discharge	Patient Rating of Care
	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)
"In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?"							
Never/Sometimes (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Usually	1.35 (0.58)	0.77 (0.79)	1.18 (0.85)	0.82 (0.83)	1.20 (0.63)	0.76 (0.67)	2.67 (0.01)
Always	0.58 (0.21)	0.49 (0.46)	0.47 (0.32)	0.39 (0.26)	1.56 (0.16)	0.50 (0.19)	8.17 (0.00)
"Does your doctor give you a written plan or instructions to help you manage your own care at home?"							
Never/Sometimes (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Usually	0.71 (0.41)	0.57 (0.41)	3.17 (0.17)	0.46 (0.24)	1.06 (0.86)	0.94 (0.91)	1.82 (0.06)
Always	0.69 (0.29)	2.05 (0.27)	1.44 (0.42)	4.65 (0.02)	1.03 (0.91)	1.09 (0.83)	5.56 (0.00)
Usual Provider of Care Index							
Low (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Middle	0.67 (0.26)	0.71 (0.69)	1.19 (0.77)	0.86 (0.83)	0.82 (0.42)	1.39 (0.44)	0.72 (0.25)
High	0.82 (0.64)	0.63 (0.63)	0.95 (0.94)	4.62 (0.06)	0.76 (0.31)	1.49 (0.37)	0.88 (0.68)

Note. Odds ratios adjusted for age (65 to 70, 70 to 79, and ≥80), race (white vs not white), number of chronic conditions(≤5,6+), number of visits (0-7,8-13,14-19, 20+), gender, deficiencies in activities of daily living (none, any, missing), marital status (married vs not married), education (high school graduate, ≤12 years, missing), income (<$10,000, >$10,000, missing) and state of residence (Arkansas, Georgia, Missouri, South Carolina, and Texas).

Appendix Table 3-3. Sensitivity Test Examining Association of Domain Scores and Quality of Care

	≥1 Eye Exam	≥1 Hemoglobin A1c Test	≥1 Cholesterol Test	Renal Disease Drug Interaction	≥1 High Risk Medications	Primary Care After Hospital Discharge	Patient Rating of Care
	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)	Odds Ratio (P-value)
Informational Continuity Between Clinicians							
Factor Score	0.62 (0.03)	0.63 (0.45)	0.60 (0.22)	0.78 (0.49)	0.99 (0.92)	0.90 (0.67)	5.51 (0.00)
Informational Continuity to the Patient							
Factor Score	0.72 (0.08)	0.67 (0.32)	0.80 (0.48)	1.59 (0.07)	1.08 (0.52)	1.12 (0.63)	2.16 (0.00)
Continuity of Care							
Factor Score	0.50 (0.00)	0.95 (0.91)	0.84 (0.62)	0.78 (0.49)	0.83 (0.22)	0.98 (0.93)	0.80 (0.18)

Note. Odds ratios adjusted for age (65 to 70, 70 to 79, and ≥80), race (white vs not white), number of chronic conditions(≤5,6+), number of visits (0-7,8-13,14-19, 20+), gender, deficiencies in activities of daily living (none, any, missing), marital status (married vs not married), education (high school graduate, ≤12 years, missing), income (<$10,000, >$10,000, missing) and state of residence (Arkansas, Georgia, Missouri, South Carolina, and Texas).

Appendix Table 3-4. Sensitivity Test Examining Lower Threshold Quality of Care Measures - Multivariate Logistic Regression Results Adjusted for Patient-Level Characteristics

	≥2 High Risk Medications	Primary Care Visit Within 30-days After Hospital Discharge
"In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians?"		
Never/Sometimes (Ref)	1.00	1.00
Usually	0.87 (0.73)	0.40 (0.16)
Always	1.06 (0.87)	0.42 (0.17)
Wald Test	0.959	0.086
"Does your doctor give you a written plan or instructions to help you manage your own care at home?"		
Never/Sometimes (Ref)	1.00	1.00
Usually	0.96 (0.90)	1.54 (0.49)
Always	1.12 (0.66)	1.32 (0.51)
Wald Test	0.712	0.525
Usual Provider of Care Index		
Low (Ref)	1.00	1.00
Middle	0.69 (0.19)	1.10 (0.85)
High	0.68 (0.20)	1.25 (0.66)
Wald Test	0.425	s0.135

Note. Odds ratios adjusted for age (65 to 70, 70 to 79, and ≥80), race (white vs not white), number of chronic conditions(>7,8-13,14+), number of visits (0-7,8-13,14-19, 20+), gender, deficiencies in activities of daily living (none, any, missing), marital status (married vs not married), education (high school graduate, ≤12 years, missing), income (<$10,000, >$10,000, missing) and state of residence (Arkansas, Georgia, Missouri, South Carolina, and Texas).

Appendix Table 3-4. Quality measure categories and specifications

Measure	Numerator	Denominator	Eligible Sample	Ref
Chronic Disease Care				
Diabetic Eye Exam	Adults receiving an annual eye exam from an optometrist or ophthalmologist during the study period	Adults with diabetes <=75 years of age	317	HEDIS
Hemoglobin A1c Test	Adults having at least 1 glycated hemoglobin during the measurement year	Adults with diabetes <=75 years of age	317	HEDIS
Lipid Screening	Adults having at least 1 LDL-C test during the measurement year	Adults with diabetes <=75 years of age	317	HEDIS
Medication Management				
Potentially Harmful Drug-Disease Interactions Total Rate (DDE-3)	Adults with a history of chronic renal failure receiving a prescription for NSAIDs or Cox-2 prescriptions	Adults age 67 and older with a history of chronic renal failure during the measurement year	466	HEDIS
Use of High Risk Medication in the Elderly Rate 1 (DAE-1)	Adults receiving one or more prescriptions considered inappropriate in the elderly	Adults age 66 and older	579	HEDIS
Use of High Risk Medication in the Elderly Rate 1 (DAE-2)	Adults receiving two or more prescriptions considered inappropriate in the elderly	Adults age 66 and older	579	HEDIS
Care Transitions				
Primary care provider follow-up within 14 days of discharge (PCP-14)	A who had an outpatient provider visit within 14 days of from the first hospital visit.	Adults discharged from an inpatient hospital from July 1, 2010 to August 30, 2011	313	(Dugoff et al. 2013)
Primary care provider follow-up within 30 days of discharge (PCP-30)	Percentage of adults following discharge from an inpatient hospital with an outpatient provider visit within 30 days of discharge	Adults discharged from a inpatient hospital from July 1, 2010 to August 30, 2011	313	(Dugoff et al. 2013)
Patient Rating of Care				
Patient rating of care	Survey respondents reporting their care was "Excellent" or "Very Good" versus "Good", "Fair", or "Poor"	Survey respondents	569	(Dugoff et al. 2013)

International Classification of Disease (ICD-9) codes were used to identify an cerebral ischemic event: 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 435.1, 435.3, 435.8, 435.9; chronic obstructive pulmonary disorder (COPD):

491, 492, 493.1, 496; major depression: 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 298.0, 300.4, 309.0, 309.1, 311; myocardial infarction: 410.x1; hip fracture: 820, V54.13; falls: E880, E884, E885.9, E887, E888; psychosis: 293, 295, 296.x4, 297, 298; mental health: 295-299, 300.3, 300.4, 301, 308, 209, 311-314; chronic renal failure: clinical classification system code 158; dementia: clinical classification code 653, any case management dementia flag for 2010 and 2011, and at least one dementia medication using NCQA HEDIS table DDE-F.

Chapter 4: Care Coordination and Adverse Events

4.1. Abstract

Background: It is anticipated that the benefits of care coordination increase with the number of doctors a patient sees. However, there is limited evidence on the relationship between care coordination and adverse outcomes in patients with multiple chronic conditions.

Objective: To examine whether higher levels of continuity of care at baseline are associated with lower risk of subsequent adverse events.

Study Sample: 1,600 adults 65 years of age and older with multiple chronic conditions. All subjects were enrolled in a Medicare Advantage Special Needs Plan living in Alabama, Georgia, Missouri, South Carolina, and Texas.

Study Design: Retrospective cohort study. Care coordination was measured using the Usual Provider of Care (UPC) index during a 6-month baseline period (July 1, 2010 to December 31, 2010). Adverse outcomes were defined as emergency room visits, hospitalizations, and preventable hospitalizations that occurred during calendar year 2011.

Results: Forty-five percent of the sample experienced at least one emergency room visit, 33.6 experienced at least one hospitalization, and 7.8% experienced a preventable hospitalization in 2011. In multivariate analyses, we do not find that the UPC Index is associated with emergency room visits, hospitalizations, or preventable hospitalizations. In models using an interaction term between the UPC and number of chronic conditions, we find that the risk of an adverse event increases with each 0.1 increase in the UPC

score in patients with 11 or more conditions compared to patients with five or fewer conditions and a UPC score of 0..

Conclusion: The relationship between continuity of care and adverse events varies by level of morbidity. Greater continuity of care does not appear to be related with better health outcomes in the most complex patients. Among healthier patients, greater continuity of care is associated with lower risk of a preventable hospitalization.

4.2. Introduction

Many care coordination interventions have proved disappointing (Nelson 2012). Over the past two decades, Medicare and other payers have launched a number of care coordination programs and most have reported null findings (Bott et al. 2009; Brown et al. 2008; Nelson 2012). However, a few programs that have benefited from Medicare's continued support that have shown some promise (Peikes et al. 2012). While conceptually, care coordination is considered a "triple aim homerun", there is limited empirical evidence to suggest that care coordination will improve care, reduce high cost adverse events, and lower health care spending (Gupta and Bodenheimer 2013). Care coordination is anticipated to be most beneficial in people with multiple chronic conditions because they see multiple clinicians during the year (Nutting 2003).

There are several plausible explanations why many of the care coordination interventions have not yet been successful. *The right formula*: these programs are not providing the combination of services or incentives necessary to meaningfully change care utilization and health. *Targeting*: Brown and colleagues suggest that these programs are not targeting the patients who can most benefit from additional services—their patient population is too healthy (Brown et al. 2012). *Poor implementation*: The interventions have identified the necessary set of services and target the appropriate people, but they aren't implementing these programs well. In this paper we examine a fourth option: care coordination programs may not benefit people with many chronic conditions. Since these patients are likely to be the most expensive people, they will affect the results.

While many care coordination programs enroll patients based on geography or a single chronic condition, we examine care coordination in the patients anticipated to be

the most likely to benefit: older adults with multiple chronic conditions (Nutting 2003; Wolff et al. 2002). Older adults with multiple chronic conditions see multiple physicians in different practices increasing opportunities for receiving conflicting medical advice, inappropriate medications, and mismanagement of chronic conditions (Burgers et al. 2010; Pham et al. 2007; Vogeli et al. 2007). The average Medicare beneficiary with five or more chronic conditions sees an average of 14 different physicians during the year (Anderson 2010). Previous studies have found that the risk of preventable hospitalizations increases with numbers of chronic conditions (Wolff et al. 2002), limitations in activities of daily living (Culler, Parchman, and Przybylski 1998), and poor self-reported health status (Culler et al. 1998; Parchman and Culler 1999). This suggests that there is opportunity for improvement in this population.

One of the most commonly used measures of care coordination is a claim-based measure of care continuity (Van Walraven et al. 2010). Conceptually "continuity of care occurs when separate and discrete elements of care are connected and when those elements of care that endure over time are maintained and supported (Reid et al. 2002)." Continuity of care can be measured using administrative data by determining the concentration of a patient's visits with one or more physicians. The most common measures are the Usual Provider of Care Index and Continuity of Care Index (Van Walraven et al. 2010). Using survey data, continuity has also been operationalized as the having a usual provider of care (Mainous et al. 2004) or length of relationship with a usual source of care (Weiss and Blustein 1996).

A number of observational studies have examined the relationship between continuity of care and outcomes (Van Walraven et al. 2010). Most studies use a cross-

sectional study design. A recent study by Hussey and colleagues found that greater continuity of care was associated with lower probability of any hospitalization and health care spending among Medicare fee for service beneficiaries with congestive heart failure, chronic obstructive pulmonary disorder, and diabetes (Hussey 2014). Other cross-sectional studies have found that higher continuity is associated with fewer hospitalizations (Weiss and Blustein 1996), better diabetes control (Mainous et al. 2004), and lower emergency room use (Burge, Lawson, and Johnston 2003; Gill, Mainous, and Nsereko 2000; Menec, Sirski, and Attawar 2005).

A limitation of cross-sectional studies is that they measure of continuity measured concurrently with the outcome of interest introducing endogeneity into the model. Formally, endogeneity exists in the model $E(y) \sim \beta x0 + \beta x1 + u$ when the explanatory variable x1 is correlated with the error term u (Wooldridge 2002). When measured simultaneously, endogeneity occurs when the value of the explanatory variable is partially determined by the outcome variable. For example, consider the following scenario:

> Mr. A is 80 years old has diabetes, hypertension, and arthritis. In the first half of the year, he saw his primary care doctor twice as well as an endocrinologist once. At the end of June, Mr. A fell at home breaking his wrist resulting in a two-day hospital stay. From July to December, Mr. A saw his primary care doctor three times as well as an orthopedist three times for follow up care. He also saw his endocrinologist once for regular medication monitoring.

> Mr A's Usual Provider of Care (UPC) score is 0.66 (2/3) for the first half of the year, 0.43 in the second half of the year (3/7), and 0.5 (5/10) for the entire calendar year.

This hypothetical example illustrates how the UPC score can be partially determined by an adverse event such as a hospitalization. This example is just one illustration. It is also possible that care patterns may be more concentrated following an adverse event or that care patterns may not vary. When considered cross-sectionally, endogeneity may lead to incorrect conclusions if the time frame that is being measured is the entire year. The problem is that people with lower care coordination scores are more likely to have a hospitalization, when, as in the above scenario, more decentralized care coordination follows the hospitalization. There are three general approaches for accounting for the time-varying nature of continuity in the literature: longitudinal models (Cheng, Chen, and Hou 2010), survival models (Christakis et al. 2001; Nyweide et al. 2013), and a pre-post design (Cheng, Hou, and Chen 2011; Gill and Mainous 1998) where continuity is measured in one period and outcomes are measured in a latter period.

Other observational studies using survival analysis and pre-post designs have also generally found a statistically significant that higher levels of continuity is associated with fewer adverse outcomes in pediatric populations (Christakis et al. 2001), Medicaid (Gill and Mainous 1998), Medicare (Nyweide et al. 2013), and Taiwan (Cheng et al. 2010; Cheng et al. 2011). However, these previous studies do not account for the patient's number of chronic conditions, which is an important predictor of ambulatory

care sensitive condition hospitalization (Wolff 2002). Furthermore, these studies have not examined whether the relationship between continuity of care and outcomes varies by level of morbidity.

The objective of this study is to examine the relationship between continuity of care and adverse health outcomes, such as emergency room visits, hospitalizations, and a subset of hospitalizations considered preventable with appropriate care, varies by number of chronic conditions. In order to compare like individuals, the initial time period includes individuals in the sample who did not experience the adverse event of interest (emergency room visit, hospitalization, or preventable hospitalization) during a 6-month baseline period. The UPC score in the baseline period with adverse health events is then used to predict adverse outcomes in the coming year.

4.3. Methods

4.3.1. Study Data

This study is a retrospective cohort study of 1,600 of older adults enrolled in a Medicare Advantage Chronic Care Special Needs Plan. The study uses administrative claims and care management data from July 1, 2010 to December 31, 2011.

All study subjects were members of a Medicare Advantage Chronic Care Special Needs Plan selected to participate in a mail survey. Survey subjects were selected based on the following criteria: age 65 as of July 1, 2010, enrolled in a plan in Arkansas, Georgia, Missouri, South Carolina, or Texas, and identified as having diabetes and at least one other chronic condition. We excluded 52 subjects who died during the study period from the analysis.

The study sample was selected using stratified random sampling. Chronic condition counts were constructed for the sampling frame using the Agency for Health Care Research (AHRQ) Clinical Classification Software and Chronic Condition Indicator using all available claims data from July 1, 2010 to March 30, 2011 (Agency for Healthcare Quality and Research 2012; Hwang et al. 2001). Individuals were then stratified by number of observed chronic conditions into five strata (subjects with diabetes and 1 additional condition, diabetes and two to three additional conditions, diabetes and four to five additional conditions, diabetes and six to seven additional conditions, and diabetes and eight or more conditions). This approach oversampled individuals with multiple chronic conditions.

4.3.2. Care Coordination

Our primary measure of care coordination is the Usual Provider of Care (UPC) Index, one of the most commonly used measures in the literature (Breslau and Reeb 1975; Van Walraven et al. 2010). The UPC Index is the proportion of a patient's physician visits to the plurality provider. Chapter 2 found that the UPC Index is representative of the continuity of care subdomain of care coordination. Other commonly used measures of continuity of care are the Continuity of Care Index (Bice and Boxerman 1977), which is measures the concentration of a patient's care across all providers, the sequential continuity index which captures the continuity of care between pairs of visits (Steinwachs 1979), and a practice-level continuity of care index (Hussey et al. 2014; Jee 2006).

The continuity of care measures were constructed using physician claims data using previously published algorithms (Jee 2006). A physician visit was defined as an

outpatient medical bill with a date of service from July 1, 2010 to December 31, 2010 using Berenson-Eggers Type of Service Codes, evaluation and management codes and visits for a procedures with a relative value greater than 2.0 (Landon et al. 2013). We excluded physician visits associated with physician specialties with limited patient care responsibilities such as anesthesiologists and pathologists (Pham et al. 2007). We only counted one bill per day per National Provider Identifier code. Practice groups were identified using the listed tax identifier on the claim.

Claims based measures are unstable when measured with few physician visits. For example, a person with two visits to the same physician will have a UPC score of 1, but a person with one visit to two different providers will have a UPC score of 0.5. For this reason we constructed the all measures in patients with four or more visits in the baseline period excluding 370 subjects.

4.3.3. Covariate Measures

The Aday-Andersen health behavior model provides a widely accepted framework that conceptualizes the relationship between individual, medical care, and environmental factors on an individual's health utilization and health outcomes (Aday and Andersen 1974; Andersen 1995). The health behavior model identifies three types of individual factors as important: predisposing characteristics, health needs, and enabling factors.

Predisposing factors are immutable characteristics of the person that influence an individual's use of health services. We measure age as a categorical variable (65-70, 71 to 80, and 80+), gender, and race (White and not White), and state of residence. Enabling factors are variables that may affect an individual's ability to access care that are external

to the medical care system. Typically enabling factors include health insurance, income, education, and marital status. These measures were included in the patient survey data, which are only available for about half of the study sample. For this reason, we test models including these measures as a sensitivity test. In the main analysis, as a proxy for income, we use the presence of any Medicaid enrollment during the baseline period. Familiarity with a health plan's processes and procedures may also promote access to primary care and reduce use of emergency room use (Allen, Wright, and Baicker 2014), so we also account for time enrolled in the health plan (< 1 year and 1 or more years). Using available survey data, we also have patient reported household income (<$10,000 vs >$10,000), education (not a high school graduate vs high school graduate), and marital status (married versus not married).

We use several different measures to capture health needs. We measure disability using the care management record of any deficiencies in activities of daily living (one or more, none, and missing). Number of chronic conditions is measured using the Clinical Classification Software and Chronic Condition Indicator using claims for the 18-month study period (Agency for Healthcare Quality and Research 2012; Hwang et al. 2001). We use all 18-months of claims data to determine the number of chronic conditions the person has because administrative data often underreports presence of chronic disease (Frogner et al. 2011). We categorize number of chronic conditions into three groups, patients with five or fewer conditions, 6 to 10 conditions, and 11 or more conditions. Consistent with other studies in the literature, we use hierarchical condition categories (HCC) score for 2010 developed for risk adjusting Medicare Advantage payments, which accounts for the patient's likelihood of using health care (Pope et al. 2004). Consistent

with previous studies HCC score was categorized into four groups: 0 to 1, 1 to 1.5, 1.5 to 2.5, and 2.5 and higher (Nyweide et al. 2013). We the patient's baseline use of physician visits (<10, 11-20, and 21+) to account for any residual differences among high and lower service utilizers as well as the occurrence of the outcome of interest during the baseline period.

4.3.4. Outcome Measures

It is thought that higher levels of continuity of care will promote the delivery of the right care at the right time preventing adverse health events such as emergency room care and preventable hospitalizations (Gupta and Bodenheimer 2013).

We examine emergency room visits and hospitalizations occurring during the calendar year 2011. We identify emergency room visits from claims data using Current Procedural Terminology codes 99281-99285 and dates of service (Kaskie et al. 2010). Hospitalizations were identified using dates of service and place of service codes. Because not all hospitalizations may be amenable to care coordination, we also examine hospitalizations considered to be preventable with appropriate outpatient care (Agency for Healthcare Quality and Research 2013). We categorized each indicator as binary where 0 represented no events during the calendar year and 1 presented one or more events.

4.3.5. Analytic Approach

We use chi-square tests to assess the bivariate differences between groups and sample-weighted logistic regression models to examine the multivariate association of continuity during the baseline period and the adverse health events occurring in calendar year 2011. Sampling weights were calculated as the inverse probability of being selected

to be in the sample. We modeled each outcome, emergency room visits, hospitalizations, and preventable hospitalizations separately.

To reduce the endogeneity between continuity and the adverse outcomes we measure continuity during a 6-month baseline period July 1, 2010 to December 31, 2010). Outcomes are measured during a 12-month observation period (January 1, 2011 to December 31, 2011).

We report the adjusted odds ratios and 95% confidence intervals. Confidence intervals were constructed as exp(log odds β+/-1.96*se). All continuity measures are constructed on a 0 to 1 scale. To facilitate interpretation we follow the convention used by Nyweide and colleagues (2013): we multiply the continuity of care measure by 10 so that the interpretation of a one-unit increase in corresponds to a 0.1 unit increase in the continuity measure.

We conducted several sensitivity tests. We examine the sensitivity of our results to the specifications of the chronic condition and continuity measure, and the inclusion of patients who experienced the event of interest during the baseline period. We examine models where the UPC index is categorized into tertiles based on the sample distribution, chronic conditions were measured continuously, and also examine using other common measures of continuity (COC Index, SECON, and Site of Care Index). While previous studies have found claims-based measures of continuity to be highly correlated (Bentler et al. 2013; Pollack et al. 2013) conceptually these measures are thought to capture different aspects of care (Jee 2006).

In order to leverage available survey responses for subjects who were alive at the end of the study period (N = 750, response rate = 48%), we used multiple imputation to

impute missing data from survey non-respondents on measures of self-reported health, marital status, income, and education. Sample characteristics of all survey respondents are available in Appendix Table 4-8. Our multiple imputation approach is discussed in the Appendix. Lastly, we also examined the association of the care coordination with adverse outcomes using a cross-sectional approach where care coordination and adverse were measured in 2011 in order to show the bias that can be introduced if endogeneity is not adequately addressed.

All analyses were conducted in R v3.0.1 (http://cran.us.r-project.org).

4.4. Results

Table 4-1 and Table 4-2 present the baseline characteristics of the entire study sample by the emergency room, hospitalization, and preventable hospitalization use during the observation period. Fifty-five percent of the sample experienced at least one emergency room visit (N=851), 42.4% experienced at least one hospitalization (N = 654), and 13.5% experienced a preventable hospitalization in 2011 (N=209). Across all three outcomes we find that patients who experienced an event were similar to those who did not in age, sex, race, and duration of enrollment in the plan. Patients who had an emergency room visit were more likely to have Medicaid coverage during the baseline period (55.8% vs 43.3%, $p<0.001$). Patients who experienced an adverse event were much more likely to have more than five chronic conditions, and to have a higher HCC score. Over 40% of patients who experienced a preventable hospitalization had 11 or more chronic conditions, compared to only 34.7% of patients who had any hospitalization, and 28.0% of patients who had an emergency room visit.

Table 4-3 presents the multivariate logistic regression results of the baseline UPC score for each of the three adverse outcomes in the subsequent 12-month period. Greater morbidity, as measured by number of chronic conditions, is consistently related with significantly higher odds of experiencing an adverse event. Compared to patients with five or fewer chronic conditions, patients with 6 to 10 chronic conditions are 2.9 times more likely to experience an emergency room visit, 3.7 times more likely to experience a hospitalization, and 6.9 times more likely to have a preventable hospitalization. Patients with 11 or more chronic conditions are 11.2 times more likely to experience an emergency room visit, 12.8 times more likely to experience a hospitalization, and 21.5 times more likely to experience a preventable hospitalization.

We find that the UPC score is not statistically significantly related to adverse outcomes. To test whether the relationship between continuity of care varies by morbidity, we ran a set of models including an interaction term between the UPC score and number of chronic conditions. Table 4-4 presents the summary odds ratios of the interaction effect between UPC score and morbidity. We find evidence that the relationship between UPC score and adverse outcomes varies by level of morbidity. The odds of an emergency room visit (OR: 1.25 (95% CI: 1.05-1.50)) and hospitalization (OR: 1.28 (95% CI: 1.05-1.55)) are statistically significantly greater in the highest morbidity group compared to the lowest morbidity group with a UPC score of 0.

Higher levels of continuity were associated with lower risk of a preventable hospitalization in the patients with five or fewer conditions, odds ratio 0.44 (95% CI: 0.31-0.63). However, in more complex patients, the odds of a preventable hospitalization increased with higher levels of continuity (OR: 1.21 (95% CI: 0.99-1.47).

To test whether our results were sensitive to the continuity of care measure, we conducted the same analysis as a sensitivity test using other common measures of continuity: the site index, SECON, and COC index. In multivariate models where we examine the association of continuity of care with adverse outcomes controlling for the number of chronic conditions our results are similar. We did not observe a statistically significant association between these measures and emergency room use, hospital use, or preventable hospitalizations in multivariate models (Appendix Tables 4-1, 4-2, 4-3). In models examining, where the relationship between continuity of care and the outcome was allowed to vary by level of morbidity using an interaction term, our results were similar to the main analysis. The odds of a preventable hospitalization decreased with each 0.1 point increase in the continuity of care measure among patients with five or fewer chronic conditions. In patients with the greatest morbidity, we find that the odds of an emergency room visit, hospitalization, and preventable hospitalization increase with higher levels of continuity compared to subjects with five or fewer chronic conditions and a UPC score of 0 (Appendix Table 4-4). In analyses using patient reported survey data, the interaction of the UPC index at baseline and chronic conditions was consistent with the main analysis.

Lastly, we examined the data using a cross-sectional approach when continuity and adverse outcomes were measured simultaneously in 2011. In this analysis, we find a consistently statistically significant relationship between continuity of care and adverse events measured during the observation period in the expected direction (Appendix Tables 4-5 and 4-6). Each 0.1 point increase in the UPC score is associated with lower odds of an emergency room visit, hospitalization, and preventable hospitalization.

Consistent with our main findings, the odds of adverse events increases with number of chronic conditions. In models examining whether the relationship between continuity of care varies by morbidity, we find no evidence of a relationship (Appendix Table 4-7).

4.5. Discussion

We find that the relationship between continuity of care and preventable hospitalizations varies by level of morbidity. After adjusting for baseline patient characteristics, among the most complex patients, higher levels of continuity of care are associated with lower risk of an adverse event in patients with five or fewer chronic conditions. We also find evidence that greater continuity of care scores are associated with greater odds of a hospitalization in patients with 11 or more chronic conditions compared to patients with 5 or fewer conditions and UPC score is 0.

When examined cross-sectionally, we find there is a robust relationship between continuity and adverse outcomes consistent with previous studies. When we examine the data using a pre-post study design, we find that on average continuity of care is not related to adverse events holding patient factors constant. When we allow the relationship between continuity of care and morbidity to vary, we find that higher levels of continuity of care are associated with lower odds of a preventable hospitalization in the lowest morbidity group,. In the most complex patients we find that the odds of an adverse event increases with higher levels of continuity of care. Since most prior studies have examined the results cross-sectionally this could explain the result showing the expected beneficial association between care coordination and adverse outcomes but this analysis could also explain the null findings in the care coordination demonstrations where care coordination did not improve outcomes.

We were surprised to find that among patients with more than 10 conditions, the relationship between continuity of care and adverse events is inversely related. These results are inconsistent with other studies of older adults in the Medicare program (Hussey et al. 2014; Nyweide et al. 2013). It is important to note that our study sample is much less healthy than these previous studies. For example, while the median HCC score in the Nyweide study was 0.93, the median HCC score in this study is 1.75. More than half of the sample was eligible for Medicaid during the baseline period, compared to about 20% of the general Medicare population (Medicare-Medicaid Coordination Office 2013). An advantage of this sample is that the presence of so many complex patients in the sample allows for subgroup analyses in the most complex patients. However, a disadvantage is that the results do not pertain to healthier older adults.

One possible interpretation of these findings is that greater continuity of care is detrimental to the most complex patients. However, we believe that there are two more likely explanations. The first is that our measures of continuity of care in this study do not adequately capture the components continuity of care necessary for better outcomes, especially in the most complex patients. This interpretation follows from the conceptual framework suggested by Chen and Ayanian (2014) that important aspects of continuity of care such as a shared medical record between clinicians and use of a care plan may not be captured by claims-based measures. If this is true, additional research is needed to identify what measures, using patient or electronic medical record data, better capture continuity of care.

Another possible explanation is that greater continuity may not be sufficient to forestall future adverse events in the most complex patients. This interpretation is

consistent with the findings of previous care coordination evaluations that have reported null findings (Nelson 2012). Medicare beneficiaries with five or more conditions account for 79% of Medicare expenditures (Anderson 2010). Patients with multiple chronic conditions are also more likely to have a disability (Anderson 2010; Komisar and Feder 2011). While this study only considered one aspect of care coordination, continuity, it is possible that clinical efforts to better centralize care through continuity may have a minimal effect of high cost events in patients with six or more chronic conditions. In addition the primary care structure, at least at this time, may not be adequately equipped to forestall adverse events in patients with six or more conditions. It may be that interventions ensuring that the most complex patients see the same doctor may not be enough.

These findings should be considered in the context of the study limitations. We focus on administrative measures of continuity of care. While the UPC Index is one of the most common measures of continuity of care in the literature, it has some important limitations. The plurality provider in the 6-month baseline period may not actually be the patient's primary physician. We sought to overcome these limitations by using other common continuity measures. Further research is needed to understand how well the UPC Index and other administrative measures capture continuity of care in terms of information sharing between clinicians and appropriate referral to specialists.

Another important limitation is that the study sample is drawn from a Medicare Advantage Special Needs Plan. Using this sample provided access to an important population that is not often studied, multimorbid older adults enrolled in a Medicare Advantage plan. It is important to note that the study sample is not representative of the

Medicare fee for service population; our study sample has higher Medicaid enrollment, non-White patients, and HCC scores. Further study is needed to examine if these relationships hold in the general Medicare population.

This study relies on commonly used metrics of care coordination and adverse outcomes. However, it is very possible that these metrics may not be valid in patients with multiple chronic conditions. The definition of a "preventable" hospitalization is likely very different in a patient with none or one condition compared to one with 10 conditions. Wolff and colleagues (2002) found that older adults with four or more conditions were 99 times more likely to have a preventable hospitalization compared to an older adult with no conditions. This study may be another indication that the measure of a preventable hospitalizations may not be appropriate in complex patients.

While we sought to overcome issues of endogeneity by measuring the UPC score in earlier time period from the outcome measurement period and excluding patients who experienced an the adverse health event in the previous period, the UPC measure may reflect a previous adverse health event occurring before the baseline period. We sought to account for baseline health using baseline physician visits, HCC score, number of chronic conditions, and limitations in activities of daily living, but it is possible that residual confounding remains. In analyses using an expanded set of patient characteristics, the results with consistent with the main analysis.

We expected to find that better care coordination would lead to better care and better care outcomes. Additional conceptual work is needed to define the components of continuity of care that are most relevant for care coordination, and to examine how to measure continuity of care for both program evaluations and quality improvement

programs. In patients with multiple physicians who work across multiple practices, measures that capture referral patterns such as social network measures may be better suited for identifying physicians likely to have a relationship and to share information on patient care (Barnett et al. 2011; Pollack et al. 2012). Alternative data sources, such as the doctor's notes in the medical record, may also provide some evidence of continuity in patient care (Dooling and Warner 2014) and patient-reported experience (Burgers et al. 2010; Singer et al. 2012).

For policymakers, these study results should temper hopes that more investment in care coordination will have immediate positive returns. Improving care in the highest cost group, patients with multiple chronic conditions, is challenging. While we find some evidence that greater continuity of care is associated with lower risk of preventable hospitalizations in the healthiest group; among the most complex patients additional care coordination services may be necessary. Consistent with previous studies, we find that patients with six or more conditions are significantly more likely to have an emergency room visit, hospitalization, and preventable hospitalization (Anderson 2010). Policymakers and health systems should consider interventions to target services to these individuals to promote access to outpatient services and reduce the likelihood of an adverse event.

4.6. Conclusion

The relationship between continuity of care and preventable hospitalizations varies by level of morbidity. Greater levels of continuity of care does not appear to be related with better health outcomes in the most complex patients. Among healthier patients, greater continuity of care is associated with lower risk of a preventable

hospitalization. Further research is needed to understand what components of care coordination may have a meaningful impact on adverse outcomes in the most complex patients.

4.7. Appendix: Multiple Imputation

In sensitivity tests, we examined models using a more comprehensive set of patient-level characteristics collected as part of a patient survey. Of the 1,548 individuals in the study sample, 750 (48%) responded to the patient survey. The survey collected patient-reported care coordination in addition to demographic information on income, marital status, and educational attainment. Among survey respondents, 3.2% did not respond to the question on marital status, 6.9% to education, 3.1% on self-reported health status, and 12.4% on income (Appendix Table 4-8).

Multivariate regression models require complete observations on all subjects. When there is missing information for a subject, that subjects is removed from the analysis. This approach, called complete case analysis, can result in biased estimates. In order to leverage all available observations in a data set, one approach is to impute missing data based on other observed variables in the dataset (Schafer (1999); Azur et al. (2011)). Multiple imputation methods rely on observed data to impute missing values, which assumes missing data are missing at random. Even when the data may be missing not at random, that is there are important predictors of the missing data that are not

observed, multiple imputation approaches are less biased than complete-case analyses (Schafer (1999); Lee and Carlin (2010)).

We constructed separate multiple imputation models for each survey variable using the "mi" package in R (Gelman et al. (2010)). We followed Rubin's (1996) advice and included all variables relevant to the survey design (sampling strata and probability of selection) in each model. Each imputation model included all variables included in the final analytic model. In addition to final analytic model, we also included other variables thought to be related to the variable of interest (Azur et al. (2011)). We expected that health status measures would be related to self-reported health status: body mass index (<25 kg/m2, 25-30 kg/m2, 30+ kg/m2, and missing), self-reported depressive symptoms, number of unique prescription medications refilled at least once for more than a 30-day supply, and any experience of an emergency room visit, hospitalization, or preventable hospitalization during the baseline period.

Based on previous studies on the social determinants of health, we also expected that the relationship between these health measures and self-reported health could vary by other demographic characteristics so we included interactions between number of chronic conditions with Medicaid eligibility, age, and race. Based on previous studies finding a robust relationship between socioeconomic status, adverse outcomes and continuity of care, we also included variables measuring care coordination (Does your doctor seem informed and up to date about your care with other physicians; How often does your doctor give you a plan or written instructions to help you manage your care at home?), in the models predicting marital status, education, and income (Culler et al. 1998).

We examined each imputation model's fit using residual and observed versus predicted plots and the predicted R of each model (Su 2004). Following the convention recommended by Su and Gelman (2004), a model is considered to fit well if the predicted R is less than 1.1. The model diagnostics indicated that the multiple imputation models did not fit the data well with R values ranging from 1.3 to 1.9.

We used the mitools package in R to fit the regression models across the multiply imputed data sets (Lumley 2012). The results were consistent with the main findings. The relationship between the UPC Index and each outcome was not related when adjusting for the number of chronic conditions. When the relationship between the UPC Index and outcomes was allowed to vary by number of chronic conditions, the UPC Index was associated with lower odds of preventable hospitalizations in the lowest morbidity group, and higher odds of a preventable hospitalization in more complex patients compared to the lowest morbidity group.

Table 4-1. Baseline Sample Characteristics by Adverse Outcomes During 2011

	Emergency Department Visit			Hospitalization			Preventable Hospitalization		
	No	Yes		No	Yes		No	Yes	
	%	%	P	%	%	P	%	%	P
Sample N	697	851		894	654		1339	209	
Age			0.449			0.079			0.509
65-70	30.8	28.6		29.8	30.3		30.2	26.3	
71-80	49.9	48.8		51.3	44.8		49	55.4	
80+	19.3	22.5		19	24.9		20.8	18.3	
Sex			0.057			0.88			0.57
Female	62.1	68		64.7	64.2		64.3	67.3	
Male	37.9	32		35.3	35.8		35.7	32.7	
Race			0.91			0.157			0.259
Not White	59.3	59		60.5	55.7		59.7	53.3	
White	40.7	41		39.5	44.3		40.3	46.7	
ADLs			<0.001			<0.001		0.051	
No	80.6	68.9		79	67.1		76.6	64.2	
Yes	7.1	15.7		8.1	17.3		10	19.2	
Missing	12.3	15.4		12.9	15.6		13.4	16.5	
Plan Enrollment			0.382			0.515			0.388
<1 year	30.9	28.3		30.4	28.3		30.1	25.9	
1+ years	69.1	71.7		69.6	71.7		69.9	74.1	
Medicaid Eligibility			<0.001			0.334			0.092
No	56.7	44.2		52.4	49.1		52.2	42.7	
Yes	43.3	55.8		47.6	50.9		47.8	57.3	
Chronic Condition			<0.001			<0.001			<0.001
<5	56.3	23.1		52.7	16.2		44.9	12.1	
6-10	37.9	48.9		39.9	49.1		42.4	44.1	
11+	5.8	28.0		7.4	34.7		12.7	43.8	
HCC 2010			<0.001			<0.001			<0.001
Low (0-1)	36.4	22.2		34.2	20.8		31.8	14.2	
Mild (1-1.5)	23.7	22.7		24.4	20.5		23.5	20.4	
Moderate (1.5-2.5)	25.4	30		27.1	27.9		27.1	30.3	
Severe (2.5+)	14.5	25.1		14.3	30.8		17.7	35	

Table 4-2. Distribution of Adverse Events During the Baseline Period By Occurrence of Adverse Events During Observation Period

	Emergency Department Visit			Hospitalization			Preventable Hospitalization		
	No	Yes		No	Yes		No	Yes	
	%	%	P	%	%	P	%	%	P
Sample N	697	851		894	654		1339	209	
Emergency Room Visit			<0.001			<0.001			0.003
No	80.6	56.9		76.4	56.1		71.9	55.9	
Yes	19.4	43.1		23.6	43.9		28.1	44.1	
Hospital Visit			0.001			<0.001			0.004
No	88.3	81.3		88.8	76.5		86.2	74.8	
Yes	11.7	18.7		11.2	23.5		13.8	25.2	
Preventable Hospital Visit			<0.001			0.001			0.031
No	98.7	95.2		98.4	94.4		97.6	93	
Yes	1.3	4.8		1.6	5.6		2.4	7	

Table 4-3. Regression Results for Baseline UPC Score and Adverse Outcomes in Calendar Year 2011

	Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
	OR (95% CI)	**P**	**OR (95% CI)**	**P**	**OR (95% CI)**	**P**
UPC	1.03 (0.93-1.13)	0.531	1.05 (0.95-1.17)	0.282	1.04 (0.90-1.18)	0.566
Chronic Conditions						
<5	1.0		1.0		1.0	
6-10	2.97 (1.81-4.86)	<0.001	3.69 (2.07-6.60)	<0.001	6.98 (1.77-27.4)	0.005
11+	11.2 (6.22-20.4)	<0.001	12.8 (6.75-24.6)	<0.001	21.5 (5.02-92.3)	<0.001
HCC 2010						
Low	1.0		1.0		1.0	
Mild	1.42 (0.81-2.48)	0.219	1.33 (0.74-2.40)	0.329	1.54 (0.56-4.22)	0.399
Moderate	1.49 (0.87-2.54)	0.137	1.56 (0.90-2.70)	0.107	1.99 (0.77-5.13)	0.15
Severe	1.88 (1.06-3.31)	0.029	2.17 (1.23-3.83)	0.007	2.70 (1.10-6.60)	0.029
Medicaid	1.31 (0.90-1.91)	0.156	0.80 (0.55-1.16)	0.251	1.37 (0.79-2.37)	0.251
Enrollment Duration						
<1	1.0		1.0		1.0	
1+	1.21 (0.82-1.79)	0.322	0.99 (0.67-1.48)	1.00	1.00 (0.56-1.80)	0.979
Physician Visits						
<=5	1.0		1.0		1.0	
6-10	0.83 (0.53-1.29)	0.422	1.13 (0.72-1.77)	0.58	1.19 (0.61-2.30)	0.605
11+	0.61 (0.36-1.04)	0.07	1.29 (0.75-2.21)	0.345	0.80 (0.38-1.68)	0.561
Baseline Event	2.64 (1.80-3.85)	<0.001	1.44 (0.92-2.27)	0.107	2.06 (0.98-4.32)	0.055
Age						
65-70	1.0		1.0		1.0	
71-80	0.71 (0.47-1.07)	0.109	0.64 (0.42-0.98)	0.04	1.33 (0.74-2.39)	0.334
80+	0.71 (0.43-1.18)	0.191	1.12 (0.67-1.86)	0.656	0.91 (0.45-1.83)	0.797
Race						
White	1.0		1.0		1.0	
Not White	1.24 (0.85-1.79)	0.25	1.30 (0.90-1.87)	0.15	1.30 (0.78-2.15)	0.299
Sex						
Female	1.0		1.0		1.0	
Male	0.96 (0.65-1.41)	0.858	1.03 (0.71-1.49)	0.865	1.28 (0.75-2.18)	0.359

^ Baseline event measures whether the outcome of interest occurred during the baseline period (e.g., whether an emergency room visit occurred during the baseline period).

Table 4-4. Odds Ratios for Interaction of Baseline UPC Score and Morbidity for the Risk of Adverse Outcomes in Calendar Year 2011

		Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
UPC Score	Chronic Conditions	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
>0	<5	1.02 (0.84 – 1.26)	0.781	1.09 (0.83-1.42)	0.541	0.44 (0.31-0.63)	<0.001
>0	6-10	0.98 (0.87-1.10)	0.728	0.98 (0.86-1.11)	0.719	0.93 (0.78-1.12)	0.448
>0	11+	1.25 (1.04-1.50)	0.017	1.28 (1.05-1.55)	0.013	1.21 (0.99-1.47)	0.062

* Models adjusted for 2010 HCC score Medicaid eligibility, enrollment in the health plan, baseline event, number of physician visits (<5,6-10,11+), age (65-70, 71-80,80+), race (White vs Not White), sex, and state.

Appendix Table 4-1. Multivariate Results for Site Index

	Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
	OR (95% CI)	**P-Value**	**OR (95% CI)**	**P-Value**	**OR (95% CI)**	**P-Value**
site_index_base	0.95 (0.87-1.03)	0.271	0.98 (0.90-1.07)	0.736	1.00 (0.88-1.13)	0.984
ccs3_186-10	2.83 (1.73-4.64)	<0.001	3.50 (1.96-6.24)	<0.001	6.83 (1.74-26.8)	0.006
ccs3_1811+	10.5 (5.80-19.2)	<0.001	11.9 (6.27-22.7)	<0.001	20.8 (4.87-89.0)	<0.001
HCC_10catmild	1.40 (0.80-2.45)	0.234	1.30 (0.73-2.34)	0.365	1.51 (0.55-4.17)	0.417
HCC_10catmoderate	1.46 (0.86-2.49)	0.158	1.52 (0.88-2.62)	0.13	1.96 (0.76-5.05)	0.162
HCC_10catsevere	1.87 (1.06-3.31)	0.029	2.17 (1.23-3.83)	0.007	2.70 (1.10-6.60)	0.03
mcaid_base	1.35 (0.92-1.97)	0.117	0.81 (0.55-1.18)	0.284	1.38 (0.80-2.38)	0.244
enroll.cat1+ yrs	1.23 (0.83-1.81)	0.289	1.00 (0.67-1.49)	0.975	1.01 (0.57-1.81)	0.95
visit_cat6-10 vst	0.78 (0.50-1.22)	0.287	1.08 (0.69-1.68)	0.733	1.15 (0.59-2.22)	0.673
visit_cat11+ vst	0.55 (0.33-0.92)	0.023	1.19 (0.70-2.02)	0.499	0.74 (0.35-1.57)	0.445
Baseline Event	2.54 (1.74-3.69)	<0.001	1.33 (0.87-2.05)	0.181	2.06 (0.99-4.30)	0.053
agecat71-80	0.72 (0.48-1.09)	0.125	0.65 (0.43-1.00)	0.052	1.35 (0.75-2.41)	0.308
agecat80+	0.72 (0.43-1.20)	0.214	1.14 (0.69-1.89)	0.603	0.91 (0.45-1.85)	0.813
racecatWhite	1.24 (0.86-1.79)	0.243	1.31 (0.91-1.88)	0.135	1.31 (0.79-2.16)	0.292
SexM	0.97 (0.66-1.43)	0.907	1.04 (0.72-1.50)	0.823	1.27 (0.74-2.17)	0.38
Georgia	2.16 (1.03-4.51)	0.04	1.40 (0.64-3.03)	0.392	1.73 (0.58-5.19)	0.323
Missouri	2.09 (0.75-5.84)	0.156	1.31 (0.45-3.76)	0.61	1.26 (0.26-6.01)	0.771
South Carolina	1.44 (0.69-3.00)	0.318	1.60 (0.73-3.48)	0.233	2.71 (0.90-8.08)	0.074
Texas	1.23 (0.58-2.62)	0.586	1.26 (0.57-2.79)	0.553	1.38 (0.42-4.44)	0.588

^ Baseline event measures whether the outcome of interest occurred during the baseline period (e.g., whether an emergency room visit occurred during the baseline period).

Appendix Table 4-2. Multivariate Results for SECON

	Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
	OR (95% CI)	**P-Value**	**OR (95% CI)**	**P-Value**	**OR (95% CI)**	**P-Value**
SECON	1.01 (0.93-1.09)	0.757	1.02 (0.94-1.10)	0.526	1.01 (0.91-1.13)	0.772
ccs3_186-10	2.94 (1.79-4.83)	<0.001	3.62 (2.02-6.47)	<0.001	6.92 (1.76-27.1)	0.006
ccs3_1811+	11.1 (6.10-20.1)	<0.001	12.4 (6.53-23.6)	<0.001	21.0 (4.98-89.1)	<0.001
HCC_10catmild	1.41 (0.80-2.47)	0.226	1.32 (0.73-2.36)	0.346	1.53 (0.56-4.18)	0.405
HCC_10catmoderate	1.49 (0.88-2.53)	0.137	1.56 (0.90-2.68)	0.107	1.99 (0.77-5.13)	0.153
HCC_10catsevere	1.88 (1.07-3.32)	0.028	2.18 (1.24-3.84)	0.007	2.71 (1.11-6.61)	0.029
mcaid_base	1.31 (0.90-1.92)	0.15	0.80 (0.55-1.17)	0.263	1.38 (0.80-2.38)	0.246
enroll.cat1+ yrs	1.22 (0.82-1.80)	0.312	1.00 (0.67-1.49)	0.972	1.01 (0.56-1.82)	0.948
visit_cat6-10 vst	0.81 (0.52-1.26)	0.373	1.10 (0.71-1.72)	0.653	1.16 (0.60-2.24)	0.65
visit_cat11+ vst	0.59 (0.35-0.97)	0.04	1.23 (0.73-2.07)	0.437	0.76 (0.36-1.58)	0.466
Baseline Event^	2.61 (1.78-3.81)	<0.001	1.38 (0.90-2.12)	0.139	2.05 (0.98-4.28)	0.055
agecat71-80	0.71 (0.47-1.07)	0.111	0.64 (0.42-0.98)	0.044	1.34 (0.74-2.42)	0.324
agecat80+	0.71 (0.43-1.18)	0.198	1.13 (0.68-1.87)	0.633	0.91 (0.45-1.84)	0.809
racecatWhite	1.23 (0.85-1.79)	0.253	1.30 (0.90-1.87)	0.15	1.30 (0.78-2.15)	0.302
SexM	0.96 (0.66-1.42)	0.876	1.03 (0.71-1.50)	0.841	1.27 (0.74-2.18)	0.369
Georgia	2.24 (1.07-4.68)	0.032	1.44 (0.66-3.12)	0.35	1.76 (0.58-5.25)	0.311
Missouri	2.11 (0.76-5.79)	0.147	1.33 (0.46-3.83)	0.586	1.28 (0.27-6.08)	0.753
South Carolina	1.50 (0.72-3.12)	0.276	1.64 (0.75-3.58)	0.21	2.73 (0.91-8.23)	0.073
Texas	1.27 (0.59-2.71)	0.534	1.28 (0.58-2.83)	0.528	1.38 (0.43-4.48)	0.583

^ Baseline event measures whether the outcome of interest occurred during the baseline period (e.g., whether an emergency room visit occurred during the baseline period).

Appendix Table 4-3. Multivariate Results for COC Index

	Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
	OR (95% CI)	P-Value	OR (95% CI)	P-Value	OR (95% CI)	P-Value
COC	1.00 (0.92-1.09)	0.876	1.03 (0.94-1.13)	0.452	1.03 (0.91-1.16)	0.62
ccs3_186-10	2.93 (1.79-4.80)	<0.001	3.65 (2.04-6.53)	<0.001	6.98 (1.76-27.6)	0.006
ccs3_1811+	11.0 (6.09-20.0)	<0.001	12.6 (6.61-24.0)	<0.001	21.3 (4.98-91.7)	<0.001
HCC_10catmild	1.41 (0.80-2.47)	0.225	1.33 (0.74-2.38)	0.335	1.54 (0.56-4.22)	0.397
HCC_10catmoderate	1.48 (0.87-2.52)	0.141	1.56 (0.90-2.69)	0.107	2.00 (0.78-5.12)	0.147
HCC_10catsevere	1.88 (1.07-3.32)	0.028	2.17 (1.23-3.83)	0.007	2.70 (1.10-6.60)	0.029
mcaid_base	1.32 (0.90-1.92)	0.148	0.80 (0.55-1.17)	0.259	1.37 (0.79-2.37)	0.253
enroll.cat1+ yrs	1.22 (0.82-1.79)	0.315	1.00 (0.67-1.48)	0.992	1.01 (0.56-1.80)	0.972
visit_cat6-10 vst	0.81 (0.52-1.26)	0.365	1.10 (0.70-1.73)	0.653	1.17 (0.60-2.26)	0.641
visit_cat11+ vst	0.59 (0.35-0.97)	0.04	1.23 (0.72-2.08)	0.433	0.77 (0.36-1.62)	0.498
Baseline Event^	2.60 (1.78-3.81)	<0.001	1.41 (0.90-2.21)	0.124	2.07 (0.99-4.34)	0.053
agecat71-80	0.71 (0.47-1.08)	0.115	0.64 (0.42-0.98)	0.043	1.33 (0.74-2.40)	0.334
agecat80+	0.71 (0.43-1.19)	0.201	1.12 (0.67-1.87)	0.645	0.91 (0.45-1.83)	0.802
racecatWhite	1.24 (0.85-1.79)	0.249	1.30 (0.91-1.87)	0.147	1.30 (0.79-2.15)	0.298
SexM	0.96 (0.66-1.41)	0.875	1.03 (0.71-1.49)	0.859	1.28 (0.75-2.18)	0.364
Georgia	2.22 (1.06-4.64)	0.033	1.44 (0.67-3.10)	0.348	1.76 (0.59-5.24)	0.305
Missouri	2.09 (0.76-5.74)	0.153	1.32 (0.46-3.80)	0.596	1.29 (0.27-6.11)	0.748
South Carolina	1.49 (0.71-3.10)	0.282	1.64 (0.75-3.56)	0.209	2.74 (0.92-8.16)	0.07
Texas	1.26 (0.59-2.70)	0.543	1.27 (0.58-2.81)	0.541	1.37 (0.42-4.43)	0.589

^ Baseline event measures whether the outcome of interest occurred during the baseline period (e.g., whether an emergency room visit occurred during the baseline period).

Appendix Table 4-4. . Odds Ratios for Interaction of Baseline Continuity of Care Score and Morbidity for the Risk of Adverse Outcomes in Calendar Year 2011

		Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
Site Index Score	Chronic Conditions	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
>0	<5	1.01 (0.82-1.23	0.944	0.93 (0.71-0.22)	0.600	0.15 (0.06-0.39)	<0.001
>0	6-10	0.89 (0.79-1.00)	0.48	0.98 (0.87-1.10)	0.706	0.88 (0.74-1.05)	0.149
>0	11+	1.09 (0.91-1.32)	0.333	1.04 (0.89-1.20)	0.653	1.20 (1.01-1.43)	0.036
SECON Score	Chronic Conditions						
>0	<5	0.99 (0.84-1.16)	0.873	0.99 (0.81-1.22)	0.943	0.65 (0.54-0.77)	<0.001
>0	6-10	0.97 (0.89-1.07)	0.586	0.98 (0.89-1.09)	0.728	0.96 (0.84-1.09)	0.497
>0	11+	1.28 (1.08-1.52)	0.004	1.20 (1.03-1.40)	0.022	1.13 (0.05-1.34)	0.178
COC Score	Chronic Conditions						
>0	<5	1.00 (0.83-1.20)	0.98	1.03 (0.81-1.31)	0.794	0.29 (1.12-0.69)	0.005
>0	6-10	0.96 (0.86-1.08)	0.49	0.98 (0.86-1.10)	0.689	0.94 (0.80-1.10)	0.418
>0	11+	1.31 (1.04-1.64)	0.02	1.27 (1.01-1.60)	0.038	1.19 (0.98-1.44)	0.077

* Models adjusted for 2010 HCC score Medicaid eligibility, enrollment in the health plan, baseline events, number of physician visits (<5,6-10,11+), age (65-70, 71-80,80+), race (White vs Not White), sex, and state.

Appendix Table 4-5. Cross-Sectional Multivariate Results for UPC and Adverse Outcomes

	Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
	OR (95% CI)	**P-Value**	**OR (95% CI)**	**P-Value**	**OR (95% CI)**	**P-Value**
UPC Score	0.63 (0.57-0.70)	<0.001	0.63 (0.55-0.73)	<0.001	0.75 (0.63-0.89)	0.001
ccs3_186-10	1.43 (0.93-2.19)	0.099	2.04 (1.30-3.22)	0.002	1.81 (0.82-3.99)	0.137
ccs3_1811+	4.02 (2.25-7.16)	<0.001	5.17 (3.00-8.89)	<0.001	5.08 (2.12-12.2)	<0.001
HCC_10catmild	1.06 (0.65-1.73)	0.805	0.91 (0.54-1.52)	0.739	1.30 (0.58-2.93)	0.516
HCC_10catmoderate	0.96 (0.59-1.56)	0.889	0.76 (0.48-1.23)	0.276	1.36 (0.62-3.00)	0.44
HCC_10catsevere	1.14 (0.67-1.93)	0.607	1.33 (0.80-2.22)	0.26	1.81 (0.86-3.78)	0.113
mcaid_base	1.27 (0.89-1.79)	0.175	0.94 (0.66-1.33)	0.747	1.20 (0.73-1.97)	0.468
enroll.cat1+ yrs	1.31 (0.92-1.88)	0.131	1.24 (0.86-1.79)	0.229	1.13 (0.65-1.96)	0.646
visit_cat6-10 vst	0.68 (0.46-1.00)	0.055	0.86 (0.58-1.27)	0.459	0.98 (0.56-1.71)	0.946
visit_cat11+ vst	0.55 (0.34-0.88)	0.014	1.06 (0.65-1.73)	0.797	0.63 (0.34-1.19)	0.159
Baseline Event	2.43 (1.68-3.54)	<0.001	1.34 (0.85-2.12)	0.2	2.02 (0.98-4.13)	0.054
agecat71-80	0.88 (0.60-1.27)	0.505	0.77 (0.52-1.12)	0.176	1.18 (0.66-2.09)	0.563
agecat80+	1.13 (0.69-1.84)	0.626	1.52 (0.94-2.47)	0.087	0.86 (0.42-1.73)	0.676
racecatWhite	1.32 (0.93-1.88)	0.113	1.32 (0.94-1.84)	0.105	1.54 (0.96-2.48)	0.071
SexM	0.84 (0.59-1.21)	0.371	0.99 (0.69-1.41)	0.972	0.85 (0.51-1.43)	0.562
Georgia	2.42 (1.25-4.68)	0.008	1.31 (0.65-2.63)	0.434	1.73 (0.55-5.43)	0.344
Missouri	2.83 (1.19-6.70)	0.018	1.45 (0.55-3.77)	0.444	1.78 (0.41-7.59)	0.433
South Carolina	1.72 (0.89-3.32)	0.102	1.36 (0.68-2.72)	0.378	2.79 (0.92-8.41)	0.068
Texas	2.16 (1.09-4.27)	0.027	1.44 (0.71-2.93)	0.306	2.05 (0.62-6.74)	0.234

^ Baseline event measures whether the outcome of interest occurred during the baseline period (e.g., whether an emergency room visit occurred during the baseline period).

Appendix Table 4-6. Cross-Sectional Multivariate Results for COC Index and Adverse Outcomes

	Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
	OR (95% CI)	**P-Value**	**OR (95% CI)**	**P-Value**	**OR (95% CI)**	**P-Value**
COC Score	0.61 (0.53-0.70)	<0.001	0.62 (0.52-0.74)	<0.001	0.74 (0.62-0.89)	0.002
ccs3_186-10	1.52 (0.92-2.52)	0.1	2.34 (1.42-3.87)	0.001	1.82 (0.82-4.02)	0.138
ccs3_1811+	4.40 (2.13-9.07)	<0.001	6.16 (3.28-11.5)	<0.001	4.94 (2.00-12.1)	0.001
HCC_10catmild	0.87 (0.48-1.56)	0.649	0.66 (0.37-1.17)	0.163	1.27 (0.56-2.89)	0.56
HCC_10catmoderate	0.59 (0.33-1.08)	0.089	0.55 (0.32-0.96)	0.037	1.31 (0.58-2.93)	0.511
HCC_10catsevere	0.78 (0.41-1.49)	0.468	1.07 (0.60-1.92)	0.803	1.70 (0.79-3.64)	0.169
mcaid_base	1.35 (0.87-2.09)	0.174	0.87 (0.57-1.31)	0.518	1.34 (0.79-2.24)	0.266
enroll.cat1+ yrs	1.58 (1.00-2.49)	0.046	1.14 (0.75-1.73)	0.515	1.12 (0.63-1.99)	0.692
visit_cat6-10 vst	0.51 (0.30-0.87)	0.014	0.55 (0.33-0.92)	0.024	0.77 (0.43-1.38)	0.385
visit_cat11+ vst	0.56 (0.26-1.19)	0.134	0.40 (0.19-0.81)	0.012	0.67 (0.29-1.54)	0.355
Baseline Event	1.02 (0.59-1.76)	0.925	1.34 (0.79-2.26)	0.268	1.25 (0.66-2.35)	0.484
agecat71-80	0.65 (0.28-1.53)	0.333	2.68 (1.28-5.63)	0.009	0.84 (0.35-1.98)	0.691
agecat80+	0.90 (0.55-1.45)	0.675	0.85 (0.55-1.32)	0.494	1.21 (0.67-2.19)	0.511
racecatWhite	1.17 (0.64-2.16)	0.6	1.82 (1.04-3.19)	0.034	0.94 (0.46-1.92)	0.881
SexM	1.54 (1.00-2.37)	0.045	1.19 (0.80-1.77)	0.372	1.57 (0.96-2.57)	0.07
Georgia	0.84 (0.54-1.32)	0.465	0.89 (0.59-1.36)	0.612	0.83 (0.48-1.44)	0.526
Missouri	2.49 (1.07-5.78)	0.034	1.34 (0.59-3.04)	0.475	2.00 (0.56-7.11)	0.28
South Carolina	2.57 (0.86-7.63)	0.089	2.25 (0.70-7.16)	0.17	2.36 (0.51-10.8)	0.269
Texas	1.78 (0.76-4.12)	0.178	1.25 (0.55-2.84)	0.586	3.34 (0.99-11.2)	0.05

^ Baseline event measures whether the outcome of interest occurred during the baseline period (e.g., whether an emergency room visit occurred during the baseline period).

Appendix Table 4-7. Odds Ratios for Interaction of Cross-Sectional Continuity of Care Score and Morbidity for the Risk of Adverse Outcomes in Calendar Year 2011

		Any Emergency Room Visit		Any Hospitalization		Any Preventable Hospitalization	
UPC Score	Chronic Conditions	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
>0	<5	0.68 (0.59-0.79)	<0.001	0.62 (0.49-0.79)	<0.001	0.88 (0.66-1.17)	0.382
>0	6-10	0.62 (0.55-0.71)	<0.001	0.61 (0.53-0.72)	<0.001	0.59 (0.45-0.79)	<0.001
>0	11+	0.70 (0.58-0.85)	<0.001	0.69 (0.57-0.82)	<0.001	0.9 (0.73-1.12)	0.358
COC Score	Chronic Conditions						
>0	<5	0.47 (0.18-1.23)	<0.001	0.34 (0.11-1.02)	0.055	0.01 (0-0.07)	<0.001
>0	6-10	0.57 (0.48-0.67)	<0.001	0.59 (0.48-0.72)	<0.001	0.54 (0.38-0.77)	0.001
>0	11+	0.65 (0.52-0.82)	<0.001	0.63 (0.51-0.79)	<0.001	0.86 (0.65-1.14)	0.304

* Models adjusted for 2010 HCC score Medicaid eligibility, enrollment in the health plan, baseline event, number of physician visits (<5,6-10,11+), age (65-70, 71-80,80+), race (White vs Not White), sex, and state.

Appendix Table 4-8: Sample Characteristic Among Survey Respondents (N = 765)

	N	%
"What is your current marital status?"		
Married	266	35.5
Not Married	460	61.3
No response	24	3.2
"What was your household income last year?"		
Less than $10,000	309	41.2
More than $10,000	348	46.4
No response	93	12.4
"What is the highest grade or level of school that you have completed?"		
High School Graduate or GED	287	38.3
Some High School or Less	412	54.9
No response	51	6.8
"In general, how would you rate your overall health?"		
Fair/Poor	365	48.7
Good	362	48.3
No response	23	3.1
Age		
65-70	219	29.2
71-80	370	49.3
80+	161	21.5
Race		
Not White	425	56.7
White	325	43.3
Chronic Conditions		
<5	158	21.1
6-10	343	45.7
11+	249	33.2
Deficiencies in Activities of Daily Living		
None	587	78.3
1+ ADLs	98	13.1
Missing	65	8.7

Chapter 5: Conclusion

5.1. Summary

This thesis examines the properties of care coordination in a sample of older adults with multiple chronic conditions. The three empirical studies explore how to measure care coordination in this population, the correlation of care coordination measures with quality of care and patient rating of care, and whether the relationship between continuity of care and health outcomes varies by level of morbidity. While there is a rich literature on care coordination, few studies have examined care coordination in a sample of older adults with multiple chronic conditions—the population perceived to be most likely to benefit from these interventions. In addition, few studies measure multiple dimensions of care coordination, which may limit their ability to comprehensively examine care coordination.

In Chapter 2, we find three measures that can be used to assess different dimensions of care coordination in older adults with multiple chronic conditions: the Usual Provider of Care (UPC) Index captures continuity of care; "Does your doctor give you a written plan or instructions to help you manage your own care at home" assesses information flow to the patient; and "In the last 6 months, how often did your doctor seem informed and up-to-date about the care you received from specialist physicians" evaluates information continuity between clinicians. This study finds that claims-based measures of care coordination are orthogonal to the other two observed dimension of care coordination.

In Chapter 3, we examine the relationship of care coordination measures with quality of care and patient rating of care. It is generally thought that care coordination interventions will improve quality of care, but few interventions have reported positive results. In this study, we extend the literature by examining multiple dimensions of care coordination and their relationship with commonly used measures of quality. Consistent with other studies, we find limited evidence that care coordination interventions may have beneficial effects on quality of care. However, we do find a strong relationship between survey measures of informational continuity between clinicians and informational continuity to the patient with higher patient rating of care. In addition, patients with renal disease receiving the highest level of care informational continuity and continuity of care were more likely to not be prescribed a contra-indicated medication.

In Chapter 4, we investigate whether the relationship between continuity of care and preventable hospitalizations varies by level of morbidity. We find that greater levels of continuity of care are associated with lower risk of a preventable hospitalization in the healthiest patients. It appears that care coordination has a beneficial impact for people with 5 or fewer chronic conditions, but not in the more complex patients. Among the most complex patients, higher levels of continuity of care are associated with greater risk of an adverse event compared the the healthiest groups with a no continuity.

5.2. Study Limitations

The findings from these three studies should be considered in the context of the study limitations. A key limitation is that the survey instrument, the Hopkins Chronic Care Survey, has not been validated. While most of the survey items are drawn from

previously validated surveys, modified and new items may behave differently in this study sample.

The study sample is limited to older adults with multiple chronic conditions in a single Medicare Advantage Special Needs Plan. How Care Improvement Plus members view experience care may not translate to other Special Needs Plans that offer different services in different patient populations or to Medicare Advantage plans or fee for service Medicare. In addition, the patient survey data may be subject to selection bias. In addition, the findings of presented are descriptive. Without a true comparison group, we cannot assess a causal association between care coordination and quality of care or health outcomes.

The study data focuses on the patient's experience of care as measured using patient survey and administrative claims data. It is possible that care may be coordinated, but patients do not see their provider's activities occurring "behind the curtain" or outside the exam room. Additional research is needed to examine the providers' perspectives on care coordination and its correlation with the patient's point of view.

Lastly, the study may be underpowered to detect a statistically significant difference in quality of care and adverse health outcome measures. The study powered to detect a 15% difference in quality of care measures.

5.3. Study Strengths

This study also has a number of strengths. First, the results of this study provide a valuable contribution to the literature in investigating the nature of care coordination in an understudied population relative to their anticipated benefit: older adults with multiple chronic conditions. Prior studies have largely focused on working age adults or children.

This study is the first to examine issues of care coordination measurement in older adults with multiple chronic conditions, a priority population for policymakers (U.S. Department of Health and Human Services 2010).

In addition, the data used in this study is a proprietary data set collected to assess care coordination in older adults with diabetes and other chronic health conditions. The study includes both patient report and administrative measures providing multiple windows into the patient's care experience. Previous studies in this area have typically used either survey data or administrative data. While no gold standard exists for care coordination measurement, with these data, we are able to assess the internal construct validity of care coordination measures using multiple data sources. In addition, these data used a stratified sampling strategy to try to study hard to capture older adults who have multiple chronic conditions.

5.4. Policy Implications

This study also has important policy implications. As policymakers turn to reforming the health care delivery system, care coordination measures may provide important feedback on care utilization patterns. Evaluations that only use claims-based measures of care coordination will not capture important dimensions of care coordination – information flow to the patient and information continuity between clinicians – leading to incomplete program evaluations. At worst, pay for performance programs focusing on either claims or patient survey measures may create perverse incentives driving providers away from providing comprehensive care coordination, which could have adverse effects on the patients who most need these services, patients with multiple chronic conditions.

In addition, performance measures that capture different aspects of care coordination can provide important feedback to providers about not just how well their practice is doing, but how well other providers in the community are doing. Clinicians could also consider incorporating patient survey measures at the point of care to identify potential care coordination problems as early as possible.

This thesis presents new information for policymakers and health insurers on what types of care coordination are most likely to improve patient rating of care and clinical quality for older adults with multiple chronic conditions. In order to incentivize plans to emphasize care coordination, Medicare could increase the number of 5-star rating system measures assessing care coordination quality by including measures of whether the clinician offered the patient written plan or instructions to manage his or her care at home. In addition, Medicare and health plans could encourage physicians to better coordinate care by reimbursing providers for consulting with other physicians and providing care plans at every visit.

While we find investing in care coordination may have beneficial impacts on patient rating of care and some aspects of care quality, we do not find that continuity of care may have an immediate benefit for patients with six or more chronic conditions. Patient targeting is a key component of successful care coordination programs. For policymakers, these study results should temper hopes that more investment in care coordination will have immediate positive returns in the most complex patients. Policymakers and health systems should consider interventions to target services to these individuals to promote access to outpatient services and reduce the likelihood of an adverse event.

5.5. Future Research

This thesis addresses a number of important questions for providers and policymakers. This research also raises a number of important questions that could not be answered in this thesis. One area for further study is to examine the reliability of the Hopkins Chronic Care Survey over time and via other interview modes (telephone or physician office).

An important question I could not answer in this thesis is whether patient experiences of care coordination are related to mortality. A previous study assessing longitudinal continuity in Medicare patients did find higher mortality rates among patients with poor continuity (Wolinsky et al. 2009). Previous studies have used patient reported health status measures and life table methods to construct healthy and disabled life expectancies. It would be interesting to extend the evidence-base by examining differences in life expectancy by patient experiences of care coordination. For example, this analysis would quantify, in years, differences in life expectancy between patients who report their care is well organized and patients who report their care is poorly organized.

Lastly, an important issue to consider is to examine which quality of care measures are most meaningful in older adults with multiple chronic conditions. In the context of current payment reform initiatives that will emphasize clinician and hospital performance based on quality of care measures, an important and understudied issue is which quality measures actually health outcomes that are meaningful to patients with multiple chronic conditions. Quality measures that are well-defined but not related to

outcomes may distract physicians from other important aspects of care and may dis-incentivize physicians from caring for complex patients who are not difficult to treat.

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Vita

Eva H DuGoff
Department of Health Policy & Management
Bloomberg School of Public Health
Johns Hopkins University
624 N. Broadway, Rm 301
Baltimore, MD 21205
edugoff1@jhu.edu

RESEARCH INTERESTS

Health services research; health outcomes; patient experiences; health care delivery; multi-morbidity

ACADEMIC POSITION

Assistant Professor, Department of Population Health Sciences — Sept 2014
School of Medicine and Public Health
University of Wisconsin-Madison

EDUCATION

PhD, Health Services Research and Policy — August 2014
Bloomberg School of Public Health
Johns Hopkins University
Thesis: Care Coordination in Older Adults with Multiple Chronic Conditions
Committee: Gerard Anderson (Advisor), Karen Bandeen-Roche, Judy Kasper, and Bruce Leff

MPP, Health Policy — May 2008
Trachtenberg School of Public Policy and Public Administration
George Washington University

BA, Psychology and Philosophy (Honors) — May 2002
Georgetown University

Study Abroad — 1998-1999
University of St. Andrews (UK)

POLICY EXPERIENCE

Center for Medicare and Medicaid Innovation Nov 2013-Jun 2014
Centers for Medicare & Medicaid Services, Baltimore, MD

Office of U.S. Senator Ron Wyden (D-Ore.) Jan 2008-Aug 2009
United States Senate, Washington, DC

Office of U.S. Representative Jan Schakowsky (D-Ill.) Aug 2006-Dec 2006
United States House of Representatives, Washington, DC

Medicare Rights Center Sept 2004-June 2006
Washington, DC and New York, NY

GRANTS

Identifying Successful Programs Treating High Cost High Need People
Role: Co-Investigator (PI: Gerard F. Anderson)
Type: Foundation
Funder: The Commonwealth Fund
Funding Period: May 2014 – April 2015

Alvin R. Tarlov & John E. Ware Jr. Award in Patient Reported Outcomes
Type: Dissertation Award
Funder: Health Assessment Laboratory, Dartmouth College
Funding Period: 2011 - 2012

National Research Service Award
Type: T-32 Training Award
Funder: Agency for Healthcare Research and Quality
Funding Period: 2009 - 2011

PUBLICATIONS & PRESENTATIONS

JOURNAL ARTICLES

1. Pollack CE, Wang H, Bekelman JE, Epstein AJ, Liao KJ, **DuGoff EH** , Armstrong K." Physician social networks and variation in rates of complications following prostatectomy" *Value in Health*. Forthcoming.
2. **DuGoff EH**, Canudas-Romo V, Buttorff CB, Leff B, Anderson GF. "Multiple Chronic Conditions and Life Expectancy: A Life Table Analysis" *Medical Care* 2014 Aug;52(8):688-94.
3. Segal JB, **DuGoff EH**. "Building Blocks for Measuring Care Coordination with Claims Data" *Population Health Management* Epub 2014 March 7.
4. **DuGoff EH**, Bekelman J, Stuart EA, Armstrong K, Pollack CE. "Surgical

Quality is More than Volume: The Association Between Changing Urologists and Complications for Patients with Localized Prostate Cancer" *Health Services Research* 2014 Aug;49(4):1165-83. Epub 2014 Jan 24.

5. Stuart EA, **DuGoff EH**, Abrams M, Salkever D, Steinwachs D. "Estimating Causal Effects in Observational Studies using Electronic Health Records: Challenges and (Some) Solutions" *eGEMS (Generating Evidence & Methods to Improve Patient Outcomes)* 1(3): Article 4.
6. Roberts ET, **DuGoff EH**, Castillo RC, Heins SE, Anderson GF. "A Decomposition Analysis of Medicare Expenditure Growth Among Injured Workers" *Journal of Health Care Finance* Winter 2013:40(2): 59-74.
7. **DuGoff EH**, Dy SM, Giovanetti E, Leff, B, Boyd, CM. "Setting Standards at the Forefront of Delivery System Reform: Aligning Care Coordination Quality Measures for Multiple Chronic Conditions" *Journal of Healthcare Quality* 2013 Sep;35(5): 58-69.
8. **DuGoff EH**, Stuart EA, Schuler, M. "Generalizing Propensity Score Results: Applying Matching Methods to Complex Survey" *Health Services Research* 2013 Jul; 48(4): 1227-1550.
9. Heins SE, Feldman DR, **DuGoff EH**, Wegener ST, Castillo RC. "Development and Evaluation of a Categorization Methodology for Occupational Back and Shoulder Injuries using Claims Data" *Health Services and Outcomes Research Methodology* 2013 Jul 26:1-17.

REPORTS & COMMENTARY (NOT PEER REVIEW)

1. **DuGoff EH**, Dy SM, Boyd CM. "Measuring Care Coordination for People with Multiple Chronic Conditions" International Research Community on Multimorbidity (IRCMo), January 2014. Available at: http://crmcspl-blog.recherche.usherbrooke.ca/?p=890.
2. **DuGoff EH**, Weiner J. "Demystifying Active Purchasing: Tools for State Health Insurance Exchanges." Maryland Health Care for All, November 2011.
3. Gitlin, LN, Szanton, SL, **DuGoff EH**. "Supporting Individuals with Disability Across the Lifespan at Home: Social Services, Technologies, and the Built Environment." SCAN Foundation, Spring 2011.
4. **DuGoff EH**. "Towards a Better State: Fostering Dialogue Between the Supreme Court and the Public Through a Public Comment Period." *Harvard Law & Policy Rev*. (Online) (Mar. 31, 2008).
5. **DuGoff EH**. "Medicare for All: Issues of Policy and Politics." *The Current* 10 (Spring 2007): 85-102.
6. Kessler R, **DuGoff E**, and Davenport K. "News from the Trenches: Consumers Speak Out On Medicare Needs." Medicare Rights Center, New York, 2005.

MANUSCRIPTIONS UNDER REVIEW

1. Canudas-Romo V, **DuGoff EH**, Wu AW, Anderson GF. "Life Expectancy in 2040: What Do Clinical Experts Expect?"
2. Roberts ET, **DuGoff EH**, Swedler D, Heins SH, Feldman D, Wegener ST, Trujillo A, Canudas-Romo, V, Castillo RC, Anderson GF. "Adherence to Clinical Practice Guidelines: Does it Hasten Return to Work?"

MANUSCRIPTS IN PROGRESS

1. **DuGoff EH**, Canudas-Romo V, Buttorff CB, Leff B, Anderson GF. "Does Delaying Disease Onset Affect Lifetime Medicare Spending?"
2. **DuGoff EH**. Pollack CE, "Examining Continuity of Care Over Time and Health Outcomes"
3. Pollack CE, **DuGoff EH**. "Calculating Life Expectancy in Clinical Practice to Support Cancer Screening Decisions"

INVITED PRESENTATIONS

1. **DuGoff EH**, "Clinical Predictions of Life Expectancy" Presentation at the Mid-Atlantic Actuarial Club, Baltimore, MD, 2013.
2. **DuGoff EH**, "Continuing the Covenant in an Era of Change: Social Security and Health Care, the Twin Pillars of a Just Society" at Toward a New New Deal: FDR's Liberalism and the Future of the American Democracy, Roosevelt Institution, Washington, DC, 2008.
3. **DuGoff EH**, "Towards a Better State: Fostering Dialogue Between the Supreme Court and the Public Through a Public Comment Period." Presentation at the Georgia Political Science Association Conference, Savannah, GA, 2007.
4. **DuGoff EH**, "Policy Recommendations for the Work Support System." Roosevelt Institution Policy Expo, Washington, DC, 2007.

POSTER PRESENTATIONS

1. **DuGoff EH**. "Association of Patient Experience of Care Coordination and Self-Reported Outcomes in Older Adults with Multiple Chronic Conditions" AcademyHealth Annual Research Meeting, Baltimore, MD, June 26, 2013.
2. **DuGoff EH**, Armstrong K, Bekelman J, Stuart EA, Pollack CE. "Changing Surgeons is Associated with Improved Outcomes for Patients with Localized Prostate Cancer" AcademyHealth Annual Research Meeting, Baltimore, MD, June 26, 2013.
3. Roberts ET, **DuGoff EH**, Swedler D, Heins SH, Feldman D, Wegener ST, Trujillo A, Canudas-Romo, V, Castillo RC, Anderson, GF. "Adherence to Clinical Practice Guidelines: Does it Hasten Return to Work?"

AcademyHealth Annual Research Meeting, Baltimore, MD, June 26, 2013.

4. Segal JB, **DuGoff EH**. "Necessary Metrics for Evaluation of Coordination of Care of Individuals with Diabetes Mellitus", 28th International Conference on Pharmacoepidemiology & Therapeutic Risk Management, August 25, 2012.
5. **DuGoff EH**, Stuart EA, Schuler, M. "Generalizing Propensity Score Results: Applying Matching Methods to Complex Survey" 2012 DEcIDE Methods Symposium, Rockville, MD, June 12, 2012.
6. **DuGoff EH**, "Association of Type of Training with Home Health Aides' Confidence on the Job," Student Poster Session, AcademyHealth Annual Research Meeting, Seattle, WA, June 12, 2011.
7. **DuGoff EH**, "Analysis of Medicare Prescription Drug Plan Benefit Design by Plan Type and Restrictiveness." Student Poster Session, AcademyHealth Annual Research Meeting, Washington, DC, 2008.
8. **DuGoff EH**, "Analysis of Medicare Prescription Drug Plan Benefit Design by Plan Type and Restrictiveness." Poster Session, Trachtenberg School Research Showcase, George Washington University, Washington, DC, 2008.

PEER REVIEW REFEREE

Journal of General Internal Medicine
Medical Care
Preventing Chronic Disease
Journal of Healthcare Quality

TEACHING

Guest Lectures

"Introduction to US Government" in Johns Hopkins University MPP Orientation	2013
"Literature Review and Synthesis for Policy" in Health Policy Analysis and Synthesis	2012, 2013, 2014

Teaching Assistant

Health Policy Analysis and Synthesis (Dubay, Anderson)	2011, 2012*, 2013
Regulation of Intimacy (Rosen)	2013, 2014
Introduction to Health Policy (Anderson)	2010, 2011*, 2012*
Public Health Policy Formulation (Frattaroli, Teret)	2010, 2011*, 2012
Making Change Through Policy (Teret, Rutkow)	2010, 2012

* denotes lead teaching assistant

HONORS & AWARDS

Johns Hopkins University

Marilyn Bergner Award in Health Services Research	2014
Hal Cohen CareFirst Blue Cross Blue Shield Scholarship	2013
Best Teaching Assistant Award, Department of Health Policy and Management	2012

George Washington University

Outstanding Student Achievement, Trachtenberg School	2008
1st Place in the Trachtenberg School Research Showcase	2008
Pi Alpha Alpha Honor Society	2008
Career Development Award	2006-2007

Georgetown University

Dean's List	2000-2002
Big East All-Academic Team	2001

SERVICE

Johns Hopkins University

Faculty Search Committee in Department of Health Policy and Management
Student Member 2013

Committee on Equity, Diversity, and Civility
Member 2011-2013

Diversity Leadership Council
Member 2011-2013
Chair, Retention Subcommittee 2012-2013

MEMBERSHIPS

AcademyHealth
Gerontological Society of America
Society for Medical Decision Making